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ARTICLES

2,2-BIS(p-CHLOROPHENYL)-1,1,1-TRICHLOROETHANE (DDT) DETERMINATIONS IN TISSUES, BODY FLUIDS AND EXCRETA OF HUMAN SUBJECTS [1]

BY

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The recent unfavorable reports from publications of articles dealing with the toxicity of DDT have caused considerable public alarm concerning the hazards of using this substance as an all-purpose insecticide.

Since its widespread introduction in 1943, the Armed Services have utilized many tons of DDT in the control of insect and disease-bearing vectors throughout the world. The employment of specific insecticide crews in these programs over long periods of time presented excellent opportunities for the potential buildup of toxic tissue levels.

Extensive experimentation by various workers has produced conclusive evidence that DDT can be readily determined in animals by chemical analyses when toxic or sub-lethal doses are administered orally. Studies by Laug (1) indicate that DDT can be detected chemically in tissues, body fluids and feces of animals acutely poisoned by oral doses of DDT in digestible oil. The insecticide was reported in all fat examined but was concentrated in the perirenal fat in amounts 50 to 100 times greater than in other tissues. Toxic doses produced characteristic neurologic symptoms and the concentration of DDT in organs was explained on the basis of their specific fat content. Laug and Fitzhugh (2) reported the results of studies on rats chronically exposed to DDT for periods of six months to two years. The survivors from this chronic exposure *(oral feeding)* exhibited only moderate tremors during the initial phase of the experiment and later appeared to recover completely.

Prolonged exposure and contact with this agent in its various diluents or solvents had further increased the speculation that sufficient quantities may be absorbed through skin or mucous membranes to produce clinical symptoms of DDT poisoning.

In view of the active participation of military personnel in preventive medicine programs on overseas bases and in the Continental United States, a preliminary study was conducted by the investigators on a long series of laborers presenting unusual and prolonged environmental contact with DDT. A special effort was made to obtain the cooperation of those

[1] RESEARCH PROJECT NM 005 052/7. REPORT NO. I. The opinions or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or the endorsement of the Navy Department.

ACKNOWLEDGEMENTS . . . . Acknowledgement is made to Cdr. J. S. COWAN, MC, USN, Naval Medical Field Research Laboratory; Capt. T. L. ALLMAN, MC, USN, U. S. Marine Corps Air Station, Cherry Point, North Carolina; Dr. E. P. LAUG, Div. Pharmacology, Food and Drug Administration, Washington, D. C., Capt. J. L. FRAZER, MC, USN, Marine Barracks, Quantico, Virginia; and to Cdr. P. J. GIOTTA, MC, USN, U. S. Naval Hospital, Camp Lejeune, North Carolina, for providing professional assistance during the course of the experiments.

persons who presented histories of lengthy contact without regard to medical examination as the primary method of separation. Selected individuals most likely to demonstrate DDT concentrations in fat deposits of the body were taken from experienced malaria, insect pest and rodent control personnel. Their chief occupations consisted of compounding and mixing DDT-oil formulations, the dissemination of these solutions by means of the DDT-fog generator, the application of larvicides and adulticides by means of knapsack and power sprayers or the distribution of DDT dusts by hand-operated dusters in routine pest control operations.

In contrast to the many "disturbances" of body function as reported by Biskind (3) in a highly uncontrolled study, there were no signs or symptoms of illness attributable to DDT in any of our subjects. Biskind attempted to correlate reported exposures to DDT with cases of gastroenteritis and the elusive "virus x" appearing in a series of patients examined by him. He neither confirmed the presence of a virus as the etiologic agent producing symptoms simulating those reported for DDT poisoning nor did he demonstrate by chemical means the presence of DDT in tissues, body fluids or excreta in this same series of patients. His conclusions, based solely on obtaining confirmative reports of exposure to DDT of any type, do not agree with the complete laboratory findings, case histories and results of specific chemical analyses obtained by us.

The present study represents the first effort chemically to detect DDT in biopsied fat from apparently healthy human subjects. In addition to tissue examination, twenty-four hour urine samples, feces and whole and citrated blood were obtained for chemical analyses. *In the first series recently completed, no DDT was detected in the material under study from sixteen (16) individuals detailing histories of exposure by contact for periods varying from six months to three years;* one subject presented a history of daily contact for a period of five years.

In a personal communication, Laug suggested that the presence of excessive quantities of nonsaponified fat or oxidative byproducts formed during analysis would seriously interfere with the detection of DDT. Thus any small quantity of DDT (possibly expressed in fatty tissue examined by one of us [L.J.B.]) would be difficult to evaluate by the usual colorimetric procedures. In these instances, the technique of Clifford (4) was followed whereby pancreatic lipase, prepared in the laboratory from fresh hog pancreas, was used as a lipolytic agent for the biopsied fat and fat-containing tissues. Specimens were subjected to a forty-eight hour period of lipolysis and extreme care was taken to eliminate interfering oxidative by-products. By this method, one gram of abdominal fat was reduced to approximately 50 milligrams of a nonsaponifiable residue. This material was then nitrated and analyzed by the procedure of Schechter et al. (5) in view of the extreme accuracy of their method in determining small quantities of DDT in suitable extracts.

In this series of human subjects having past histories of lengthy exposures, and in whom the DDT needed to be absorbed through the skin or inhaled from dusting or from aerosol operations for final detection, none could be demonstrated in any sample. The animals used for controls were sacrificed upon termination of the experiment and DDT was reported in amounts indicating a definite correlation between tissue and oral dosage levels.

These negative results obtained from human volunteers are important and significant observations. Since DDT is preferentially contained in fat, its presence represents actual storage rather than passive or temporary "flooding" of organs or fatty tissues. We are led to conclude, therefore, that (a) handlers utilizing normal precautionary measures not only fail to exhibit symptoms of DDT poisoning, but, (b) show no chemically detectable accumulation of DDT in body fat as a result of prolonged external contact with this agent. It likewise indicates that

malaria control operators can safely utilize the services of personnel over long periods of time without fear of developing toxic tissue levels of DDT.

Military personnel and their dependents exposed to DDT in areas where nightly fog applications are made have not exhibited any untoward reactions to oil fog or DDT proper. In many instances these subjects have been residents of "endemic" fog areas for three years or longer. It is felt that the cross-section of population represented on three large Marine Corps bases provided a significant sample from which our epidemiologic and clinical observations were made.

It must be stated, however, that DDT, like many insecticides, is lethal to man when ingested in high dosages; yet many of the deaths recorded in the literature are due in reality to pathologic alterations in tissues produced by the solvents ordinarily used such as kerosene or other organic diluents. It seems unlikely that the average individual would ingest sufficient DDT by accidental means to produce death as a result of changes in the central nervous system or in other vital organs. Individual sensitivities to this agent must also be considered. These individual idiosyncrasies must be eliminated by a systematic and careful analysis in determining plausible explanations for new disease entities.

Adequate personnel protection as practiced by insecticide distributors, the consideration given to recommendations for use, and the careful indoctrination and rotation of exposed individuals through varied duties within the organization have been in part responsible for the small number of toxicities known to date.

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DISTRIBUTION RECORDS OF *MANSONIA* BLANCHARD (DIPTERA, CULICIDAE) IN TEXAS

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Our attention was recently focused upon the genus *Mansonia* by the light trap collection of four specimens of *M. titillans* (Walker) at Austin, Texas. This was considered unusual as the mosquito had been previously taken by the writers in Texas only in the semi-tropical Lower Rio Grande Valley (Cameron and Hidalgo Counties).

The importance of *Mansonia titillans* as a pest mosquito in the Lower Rio Grande Valley has not been widely recognized. King, Bradley and McNeel (1942) state that the species is found in the United States only in southern Florida. Matheson (1944) also records the mosquito only in southern Florida in the United States. *M. titillans* has been reported from

Cameron and Hidalgo Counties in Texas by McGregor and Eads (1943) and Randolph and O'Neil (1944) and from Cameron County by Joyce (1948).

During the months of April, May and June in 1942, extensive field collections of adult mosquitoes were made in the Lower Rio Grande Valley in the course of a cooperative project on equine encephalomyelitis between the Hooper Foundation for Medical Research, San Francisco, California and the Texas State Department of Health. Over 16,000 mosquitoes were collected alive in light traps; the most abundant species proved to be *Psorophora confinnis* (Lynch Arribalzaga) (2,766), *Culex erraticus* Dyar and Knab (2,615), *Anopheles quadrimaculatus* Say (1,903) and *Mansonia titillans* (Walker) (1,785). The *M. titillans* attacked viciously and were probably second only to *P. confinnis* in annoyance to humans.

After the Austin, Texas, collection of *Mansonia titillans,* an examination of the State Department of Health mosquito collection revealed a female of this species which had been taken in 1942 by light trap (latitude 33.50) from Grayson County, Texas. This county is on the border between Texas and Oklahoma and the collection record represents a considerable extension of the northern limits of the range of this mosquito. The previous northern limit of its range as given by King, Bradley and McNeel (1942) has been Orange County, Florida (latitude between 28° and 29°).

Pratt (1945) reported for the first time the presence in the United States of *Mansonia indubitans* Dyar and Shannon, a mosquito easily confused with *M. titillans* in the adult stage. Pratt identified larvae, pupae and reared adults collected by D. G. Denning and W. W. Wirth from the roots of *Pistia stratiotes* Linnaeus in Boca Raton, Florida, August 16, 1944. These findings cast doubt on the validity of previous United States records of *M. titillans.* A re-evaluation by Chamberlain and Duffey (1945) of Florida material previously identified as *M. titillans* showed that many specimens were actually *M. indubitans.* A similar study has been made of the *Mansonia* in the collection of the Texas State Department of Health (Table 1). The *M. titillans* were all found to be correctly identified.

As shown in Table 1 large numbers of *Mansonia* larvae were collected in the Lower Rio Grande Valley during October, 1948, to supplement the material in our collection which was checked in an effort to determine whether or not *M. indubitans* is present in Texas. However, all of the specimens taken were *M. titillans.* The larvae had typical thorn-shaped comb scales and the female a row of short spines on the posterior margin of the seventh tergite and a median series of close-set spines on the posterior margin of the eighth tergite.

King, Bradley and McNeel (1942) list water-lettuce *(Pistia stratiotes)* as the common host plant of *Mansonia titillans* in Florida. This plant is rare in Texas; the only known locality record is a spring-fed lake near San Marcos. The aquatic plant with which the larvae of this mos-

Table 1. Texas Records of *Mansonia titillans* in the Collection of the State Department of Health

Number	*County*	*Date*	*Stage*	*Collector*	*Determined By*
4	Hidalgo	9–20–41	Adult	T. McGregor	T. McGregor
2	Comeron	4–7–42	Adult	R. B. Eads	R. B. Eads
1	Grayson	4–7–42	Adult	Kerby	L. J. Ogden
1	Cameron	9–10–42	Larva	R. B. Eads	R. B. Eads
1	Travis	8–24–48	Adult	H. Hargis	"
1	Travis	8–30–48	Adult	"	"
1	Travis	10–13–48	Adult	"	"
1	Travis	10–15–48	Adult	"	"
30	Cameron	10–28–48	Larvae	R. B. Eads	"
40	Hidalgo	10–28–48	Larvae	"	"

quito has constantly been found associated in Texas has been the water-hyacinth, *Eichhornia crassipes*. Cattail, *Typha latifolia,* has been less frequently encountered. *M. titillans* is readily collected by lifting the water-hyacinths quickly into a white enameled pan. The larvae detach and can be found in the debris in the bottom of the pan. No larvae have been found still attached to the roots of the hyacinths.

Adults of *Mansonia perturbans* (Walker) have been rather commonly taken in Texas (Table 2). As far as can be ascertained only one larva has been taken although light trap records of Malaria Control in War Areas (now Communicable Disease Control), United States Public Health Service and the Texas State Department of Health show this species to be rather widely distributed over the eastern and gulf coast regions of the state. The paucity of larval records of *M. perturbans* is no doubt due to the small amount of specific collecting that has been done and should not be considered as an index to its abundance.

Table 2. Texas Records of *Mansonia perturbans* in the Collection of the State Department of Health

Number	*County*	*Date*	*Stage*	*Collector*	*Determined By*
1	Colorado	4-10-39	Adult	T. McGregor	T. McGregor
4	Cameron	5-15-42	Adult	R. B. Eads	R. B. Eads
1	Liberty	7-24-42	Adult	D. C. Thurman	D. C. Thurman
3	Jefferson	5-27-43	Adult	T. D. Weatherby	K. O'Neil
1	Harris	6-12-43	Adult	Grimsley	"
1	Hays	8-2-43	Adult	A. Lee	"
1	Hays	8-10-43	Adult	H. V. Miles	"
1	Brazoria	8-25-43	Adult	A. J. McCrocklin	"
1	Hays	9-9-43	Adult	A. Lee	"
1	Harris	9-16-43	Adult	Grimsley	"
18	Orange	9-27-43	Adult	J. D. Weatherby	"
1	Brazoria	9-25-43	Adult	A. J. McCrocklin	"
2	Harris	10-9-43	Adult	Grimsley	"
1	Harris	4-29-44	Adult	"	"
3	Orange	6-14-44	Adult	J. D. Weatherby	"
1	Jefferson	6-21-44	Adult	"	"
15	Orange	6-21-44	Adult	"	L. J. Ogden
1	Cameron	12-15-44	Larva	L. J. Ogden	"

Acknowledgement

Dr. H. D. Pratt, Communicable Disease Center, U. S. Public Health Service, examined a genitalia slide of a male taken in Cameron County, Texas, in 1943, a genitalia slide of a female taken in Travis County, October 15, 1948, and eight larvae taken in Hidalgo County, October 29, 1948. He expressed the opinion that the specimens were typical *Mansonia titillans*.

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COMPARATIVE TOXICITY OF BENZENE HEXACHLORIDE, DDT, AND PYRETHRUM TO MOSQUITO LARVAE

HARRY H. INCHO [1] AND C. C. DEONIER, *U.S.D.A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine* [2]

Benzene hexachloride has been found to be highly toxic to *Anopheles quadrimaculatus* Say mosquitoes. Slade (4) found that the gamma isomer was far more toxic than the other isomers and determined that crude benzene hexachloride contained 10 to 12 percent of this isomer. Kearns *et al.*(3) found that there was no significant difference between DDT and gamma-benzene hexachloride, regardless of the formulations used and the type of application. This paper gives the results of five experiments made to compare the effectiveness of benzene hexachloride DDT, and pyrethrum against anopheline and culicine mosquitoes.

The first three experiments were made with acetone suspensions of the chemicals in water. In the fourth experiment the test materials were dissolved in No. 2 fuel oil. The solutions were applied to the surface of water in small cartons by the method described by Incho and Deonier.(2) In the fifth experiment surface applications of benzene hexachloride dust were made on water contained in 12-inch enameled pans. The benzene hexachloride was diluted with the Loomis talc and applied by sifting through a fine-mesh screen, according to procedure previously described (Deonier *et al.*(1)).

The results of the first experiment, in which the four isomers [3] of benzene hexachloride and DDT were compared, are given in table 1. All but the gamma isomer showed relatively slight toxicity to larvae of *Anopheles quadrimaculatus.*

The gamma isomer was approximately half as toxic as DDT. The remaining isomers were toxic only at such high dosages that further comparisons were made with the gamma isomer only.

Table 2 gives the results of the second experiment, in which crude and gamma-benzene hexachloride and DDT were compared. These results, in general, substantiate Slade's observations on the toxicity of the gamma isomer. Since the alpha and delta isomers have some toxic effect at the lower dosages (table 1), their action in the crude material may add slightly to the toxicity of the crude product.

DDT again showed a higher toxic effect against larvae of *Anopheles quadrimaculatus* at a dosage of 0.005 p.p.m. than did the gamma benzene hexachloride.

The results of the third experiment, in which gamma benzene hexachloride, pyrethrum, and DDT were compared, are given in table 3. The pyrethrins were approximately half as toxic as gamma benzene hexachloride to larvae of *Anopheles quadrimaculatus* and DDT, which was more than twice as toxic as gamma benzene hexachloride at 0.005 p.p.m. caused a somewhat higher mortality of larvae than is usually obtained with this material.

Table 4 gives the results of the fourth experiment, in which gamma benzene hexachloride, DDT, and pyrethrins in No. 2 fuel oil were applied to the surface of the water. In addition to *Anopheles quadrimaculatus* the materials were tested against *Aedes aegypti* (L.) and *Culex quinquefasciatus* Say.

The pyrethrins were more toxic than gamma benzene hexachloride but less toxic

[1] Sergeant, AUS, assigned from Army Air Forces Committee on Aerial Dispersal of Insecticides, located at Army Air Forces Center, Orlando, Fla.

[2] This work was conducted under a transfer of funds, recommended by the Committee on Medical Research, from the Office of Scientific Research and Development to the Bureau of Entomology and Plant Quarantine.

[3] The authors are indebted to M. C. Swingle, of E. I. du Pont de Nemours Co., for the samples of benzene hexachloride isomers.

TABLE 1.—Comparative toxicity of four isomers of benzene hexachloride and DDT in acetone-water suspension to larvae of *Anopheles quadrimaculatus*. (3 replications.)

Isomer	*Dosage*	*Average Mortality After*	
		24 Hours	*48 Hours*
	P.p.m.	*Percent*	*Percent*
Beta	100.0	21.6	36.8
	50.0	8.3	21.0
	20.0	11.6	26.3
Alpha	5.0	100.0	..
	2.5	88.3	91.1
	1.0	5.0	12.1
Delta	5.0	100.0	..
	2.5	40.0	59.6
	1.0	6.6	22.7
Gamma	.005	16.6	36.7
	.0025	5.0	24.5
	.00125	0.0	0.0
DDT	.005	53.3	84.2
	.0025	26.6	52.6
	.00125	8.3	15.8

TABLE 2.—Comparative toxicity of crude and gamma benzene hexachloride and DDT in acetone-water suspensions to larvae of *Anopheles quadrimaculatus*. (3 replications.)

Material	*Dosage*	*Average Mortality After*	
		24 Hours	*48 Hours*
	P.p.m.	*Percent*	*Percent*
Benzene hexachloride:			
Crude	0.1	91.6	92.7
	.05	18.8	22.4
	.025	6.6	6.6
Gamma	.05	100.0	..
	.01	66.6	74.7
	.005	3.3	3.3
DDT	.01	96.6	98.2
	.005	38.3	71.1
	.0025	11.6	24.3

TABLE 3.—Comparative toxicity of gamma benzene hexachloride, pyrethrins, and DDT in acetone-water suspension to larvae of *Anopheles quadrimaculatus*. (3 replications.)

Material	*Dosage*	*Average Mortality After*	
		24 Hours	*48 Hours*
	P.p.m.	*Percent*	*Percent*
gamma Benzene hexachloride	0.05	100.0	..
	.01	80.0	100.0
	.005	35.0	45.9
	.0025	0.0	24.3
Pyrethrins	.025	86.6	96.5
	.01	18.3	62.3
	.005	0.0	0.0
DDT	.005	95.0	100.0
	.0025	85.0	100.0
	.00125	0.0	18.9

TABLE 4.—Comparative toxicity to culicine and anopheline mosquito larvae of pyrethrins, gamma benzene hexachloride, and DDT at 0.5 percent in No. 2 fuel oil when applied to the surface of water containing the larvae. (3 replications.)

Materials	*Dosage*	*Average Mortality After Indicated Period*					
		Anopheles quadrimaculatus		*Aedes aegypti*		*Culex quinquefasciatus*	
	Pounds	*24 Hours*	*48 Hours*	*24 Hours*	*48 Hours*	*24 Hours*	*48 Hours*
	per Acre	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Pyrethrins	0.01	..	..	..	..	56.6	56.6
	.005	98.6	98.6	18.3	38.3	..	..
	.0025	83.3	83.3	..	..	..	..
gamma Benzene hexachloride	.01	..	..	..	..	51.6	53.3
	.005	31.6	36.6	5.0	36.6	..	..
	.0025	10.0	10.0	..	..	..	..
DDT	.01	..	..	..	..	10.0	11.6
	.005	100	100	71.6	91.6	..	..
	.0025	95.0	95.0	..	..	..	..

than DDT to *Anopheles quadrimaculatus*. Gamma-benzene hexachloride and the pyrethrins were more toxic than DDT to *Culex quinquefasciatus* but less toxic to *Aedes aegypti*.

In the fifth experiment a dust made of crude benzene hexachloride containing about 12 percent of the gamma isomer killed 70 percent of *Anopheles quadrimaculatus* larvae when it was applied at a dosage of 1/40 pound per acre. This kill was higher with the crude material than would be expected for a material containing this amount of the gamma isomer. However, as shown in table 1, the other components of the crude material have some toxic effect, which may add to the toxicity.

SUMMARY

Tests were made of the comparative toxicity of the isomers of benzene hexachloride, pyrethrum, and DDT in acetone-water suspensions, in oil solutions, and as a dust against mosquito larvae. Four isomers of benzene hexachloride were tested against larvae of *Anopheles quadrimaculatus* Say, and only the gamma isomer, which is present at concentrations of about 12 percent in the crude product, was toxic in a dosage range comparable to DDT. Pyrethrum was less effective than DDT or the gamma isomer in acetone-water suspensions. In oil solutions applied to the surface of water containing the larvae it was more toxic than benzene hexachloride, but less toxic than DDT to *A. quadrimaculatus*. Gamma benzene hexachloride and pyrethrum were more toxic than DDT to *Culex quinquefasciatus* Say but less toxic to *Aedes aegypti* (L.).

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EFFECTIVE CONTROL METHODS USED ON BITING GNATS IN UTAH DURING 1949 (DIPTERA: CERATOPOGONIDAE) [1]

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Introduction

In many parts of Utah and other western states the small biting gnat *Leptoconops (Holoconops) kerteszi* var. *americanus* Carter is extremely annoying and pestiferous each spring for a period of about six weeks. These gnats, sometimes called "punkies" or "no-see-ums," were present in abundance when the first white men began the settlement of western North America. The inhabitants of Utah until recently have vociferously, but otherwise passively, accepted these pests as an inevitable part of the spring season.

Leptoconops kerteszi var. *americanus* was described from the vicinity of Salt Lake City by H. F. Carter in 1921. Carter considered it a variety of *Leptoconops kerteszi* which was described from Egypt by Kieffer in 1908. There is at present some question concerning the synonomy of this genus and species. Some current workers such as W. W. Wirth of the U.S.D.A., Division of Insect Identification refer to this gnat as *Leptoconops kerteszi* Kieffer and at present can find no valid reason for recognizing *americanus* Carter as a variety. The authors hope to be able to establish the identity of this gnat and provide more detailed information concerning its biology as the result of an investigation now in progress. This report will therefore be confined to the results of control measures that have been directed against this gnat in the vicinity of Salt Lake City during the past two years.

In the spring of 1948 the Salt Lake Refining Company, a subsidiary of the Standard Oil Company of California, found these gnats extremely annoying and in certain cases injurious to the health of the workmen who were constructing a large oil refinery in North Salt Lake City. It was estimated by officials in charge of construction that the gnats reduced working efficiency of the men by 10 to 20 per cent. This reduction in working efficiency occurred only during the daylight hours under favorable weather conditions, when swarms of these small gnats literally covered the workmen, crawling over their clothing, hands and face, and into their eyes, ears and hair. In addition the females are voracious feeders and fearless in their attack. They prefer to bite where the clothing fits close to the skin such as around hat bands, shirt collars and cuffs. The victim does not feel the bite for the first 30 to 60 seconds; then a slight irritation becomes noticeable. In about 10 to 15 minutes a hard white swelling has formed which becomes red and inflamed in about 30 minutes. Itching and irritation may continue for 72 hours or more depending on the susceptibility of the individual. As a result of daily exposure to the attacks of these gnats a number of the workmen quit the job and others were forced to leave the job temporarily in order to recover from the bites inflicted by the gnats. In a few instances medical attention was necessary.

1948 Investigation

The officials of the Salt Lake Refining Company requested the authors to make an investigation of the gnat problem in North Salt Lake City for the purpose of control. This investigation was started May 22, 1948 at the peak of the gnat sea-

[1] Funds necessary for the experimental and control work reported in this article were provided by the Salt Lake Refining Co. of Salt Lake City, Utah.

son. As most of the gnats were on the wing the control measures were directed primarily toward the destruction of the adults. The control measures consisted of: (1), the use of head nets and gloves; (2), repellents applied to the skin and clothing; (3), 5% DDT used as a residual insecticide on the resting places of the gnats; (4), aerial insecticides in smoke or fogs; and (5), larvicides on the few remaining larvae found in the soil. As a result of this work it was found that: (1), head nets under existing working conditions were extremely uncomfortable and impracticable but would be worn by the men in preference to exposure to the gnats; (2), of the nine highly recommended repellents used none of them provided suitable protection although some, especially dimethylphthalate, reduced the number of gnats that would alight on the skin and clothing and materially reduced biting incidence; (3), 5% DDT was very effective as a residual adulticide in destroying gnats in their resting places; (4), aerosols consisting of DDT, thanite and pyrethrum were effective under favorable conditions as a "knock down" adulticide providing temporary relief; (5), DDT showed promise of being an effective larvicide if applied at the proper time and amounts.

1949 Investigation and Control Program

Survey of Breeding Area.

On March 20 a survey was started to determine the extent and type of habitat in which gnats develop in the vicinity of the plant of the Salt Lake Refining Company. The survey consisted of taking soil samples at 200 yard intervals on a transect running due east and west for 3400 yards and on another transect that extended for 5200 yards north and south. The two transects crossed at right angles in about the middle of each transect, near the office building of the company. Soil samples were obtained by pushing a soup can, which had been opened at each end, into the soil about two inches. The can was two and one-half inches in diameter and each sample contained about ten cubic inches of soil. The gnat larvae if present were removed by washing the soil through a series of fine mesh strainers, the finest containing 76 squares per square inch. Examination and counting was done under a wide field stereoscopic microscope. The number of gnats ranged from 33 to 88 with an average of 57 per sample. In localities where larvae were present additional soil samples were taken in all directions until the limits of the breeding area were determined and plotted on a map. Approximately 250 acres of ground were found to be producing gnats. (See accompanying map, Fig. 1.)

The number of gnats per sample indicates only those present in the top two inches of soil. Larvae were usually present at greater depths at the time the samples were taken. During the 1949 gnat season 5710 gnats were collected in a trap as they emerged from 3 sq. ft. of the breeding area. At this rate approximately 83 million gnats would be produced per acre. This gives an idea of potential productivity of a gnat producing area of this magnitude.

Experimental Plots.

To determine an effective method of destroying the gnat larvae and pupae in the soil, 17 adjacent test plots, each containing 68 square feet, were selected in an area where these stages were abundant. Uniform samples were taken using the same method used in the survey. The larvae and pupae were counted and the results tabulated for each plot. One plot was used as a control and was not treated. The remaining 16 plots were treated with different concentrations of two selected insecticides in order to compare lethal effects on the gnats.

DDT and BHC (12% gamma isomer) were applied to the experimental plots in different concentrations and quantities of water. The insecticides and water were carefully measured for each plot and

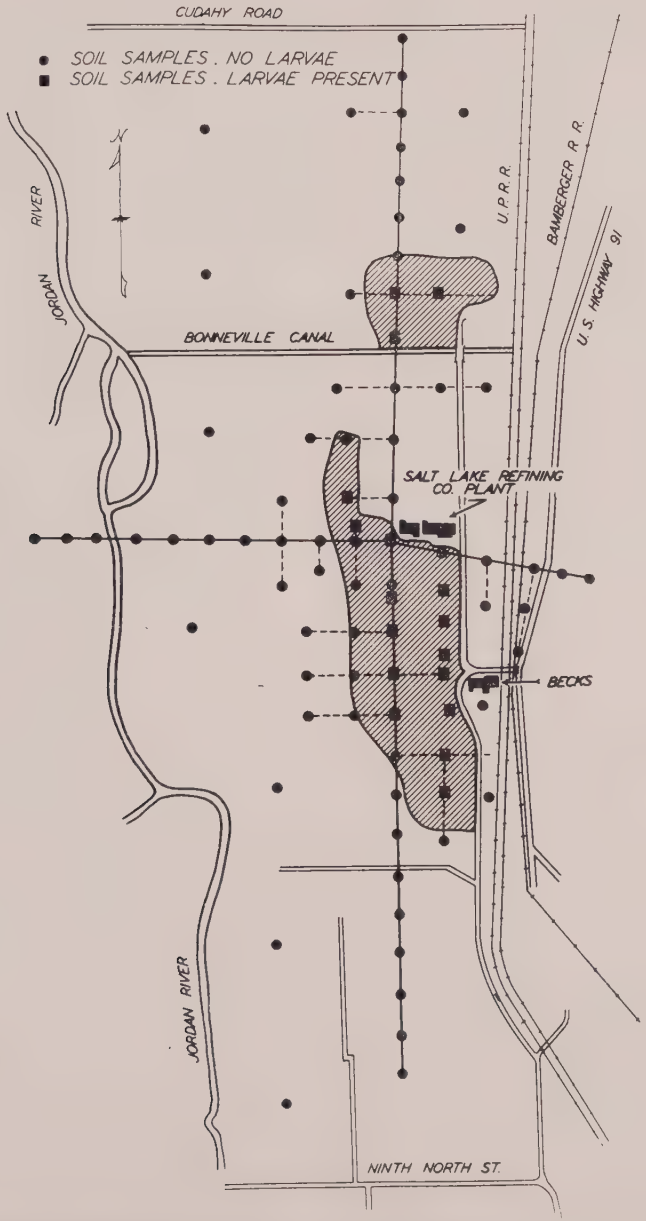

FIG. 1. (Treated areas are cross-hatched).

tabulated on a per acre basis. DDT was used at the rate of 0.1, 0.2, 0.5 and 1.0 pound per acre. The DDT was prepared from a 25% stock emulsion. Each of these amounts was applied in water on different plots at the rate of 10, 25, and 50 gallons per acre. BHC was used on the remaining four plots at the rate of 0.1, 0.2, 0.5 and 1 pound per acre in 25 gallons of water.

All applications were made with a Hudson pressure sealed spray pump of four gallon capacity operated under 40 to 50 pounds pressure per square inch. The nozzle was a "teejet" #8001.

Each plot was then sampled, by the same method previously used, to determine the percentage of larvae and pupae killed 24, 72 and 168 hours after treatment. The following table shows the results of these experiments as determined by the number of living and dead larvae and pupae found in each soil sample.

consistently high throughout successive samplings. It is also evident that DDT in amounts as low as .1 of a pound per acre, in all dilutions used, gave an average kill, at the three intervals when counts were made, of about 70%, but the kill at this amount on the pupae was below 50%. A higher percentage of kill was obtained in both larvae and pupae as the amount of DDT was increased. The dilutions of 10, 25 and 50 gallons per acre appears to have little influence on the lethal effectiveness of DDT on the gnat larvae and pupae. However, a comparison between these dilutions using one pound of DDT per acre shows a difference by the end of the season in the number of gnats emerged. (Table 3)

The plots treated with benzene hexachloride show a high percentage of kill in the first 24 hours but the killing power of BHC shows a rapid decline in subsequent samplings. This was further veri-

Table 1—Insecticide Concentrations and Results as Determined from Soil Samples

25% DDT Emulsion			24 Hours						72 Hours						168 Hours					
			Larvae			Pupae			Larvae			Pupae			Larvae			Pupae		
Plot	Lbs. per Acre	Water Gals.	D	A	%	D	A	%	D	A	%	D	A	%	D	A	%	D	A	%
1	1	10	53	11	83	4	3	57	41	8	84	6	4	60	27	3	90	14	6	70
2	.5	"	36	5	88	3	3	50	32	7	83	2	5	29	17	9	65	18	10	64
3	.2	"	37	10	79	4	6	40	39	9	82	4	9	31	16	5	76	14	10	58
4	.1	"	39	22	64	1	7	12	26	19	58	6	9	40	19	5	80	17	12	59
5	1	25	42	3	93	16	1	94	52	2	96	9	0	100	21	3	87	17	2	89
6	.5	"	66	3	95	9	8	53	29	7	80	11	3	79	18	3	85	21	6	77
7	.2	"	32	9	78	3	2	60	63	18	78	6	1	86	24	9	73	23	5	82
8	.1	"	28	7	80	3	5	38	30	6	83	5	13	28	15	7	68	27	12	69
9	1	50	29	2	93	4	0	100	27	6	82	6	2	75	11	3	78	23	5	82
10	.5	"	33	7	83	5	3	63	30	12	72	11	6	65	19	7	73	9	7	56
11	.2	"	26	12	69	4	6	40	37	22	63	7	6	54	23	8	74	18	6	75
12	.1	"	47	21	69	3	7	30	29	20	60	7	9	44	12	9	57	22	8	73
BHC (gamma isomer) 12% wettable powder.																				
13	1	25	31	0	100	2	0	100	29	2	93	3	1	75	18	7	72	21	9	70
14	.5	"	32	2	94	9	1	90	37	11	77	6	2	75	11	4	73	27	11	71
15	.2	"	26	1	96	4	2	66	29	7	80	7	4	64	16	9	64	18	12	60
16	.1	"	34	3	92	4	3	57	30	4	88	6	9	40	19	3	86	17	13	57
CONTROL (untreated)																				
17	..	..	0	46	0	0	7	0	0	29	0	0	14	0	0	11	0	0	27	0

% = Kill A = Alive D = Dead

It is evident from the above table that 1 lb. of DDT in 25 gals. of solution per acre produced a high kill of larvae and pupae 24 hours after treatment and remained

fied by the number of gnats that emerged during the season from the plots treated with BHC. (Table 3)

As a result of these tests and after due

consideration of the kind of soil, vegetation, animals present, and equipment available, it was decided that one pound of DDT per acre in 25 gallons of water would be the most practical insecticide under existing conditions.

Equipment Used.

A Dodge "Power Wagon" truck with four wheel drive and a Jeep were used to transport spraying equipment. A Bean and an Essick spray pump equipped with agitators were used and operated under 150 to 200 lbs. pressure per square inch. A spray boom containing "teejet" #8001 nozzles was attached to the back of each truck about 18 inches from the ground. A 200 foot hose equipped with similar nozzles was also attached to each pump in order to reach places inaccessible to the trucks. A few small areas that could not be reached with the power equipment were treated with Hudson pressure sealed knapsack spray pumps. The trucks were equipped with thermal aerosol generators attached to the exhaust.

Ground Treatment.

The dry salt grass *Distichlis stricta* covering much of the area in which the gnats were found developing, was burned before the soil was treated with DDT. This permitted a more even distribution and direct contact of the insecticide with the soil. The trucks were driven at a speed of approximately 3 miles per hour and the rate of discharge of the solution was regulated to about 28 gallons per acre.

The time of application of the DDT was found to be important in obtaining the best results. It was found that the most effective time for treatment was when most of the gnat larvae were concentrated in the top ¼ inch of soil and pupae were beginning to appear on the surface of the ground. This period in the development of the gnat is determined from the examination of soil samples as they are taken each day from different parts of the breeding area. As the time of development varied somewhat throughout the breeding area, it was possible and necessary to direct the work each day to the areas where it would be most effective.

Residual Insecticide.

Five per cent DDT was used as a residual on buildings, oil tanks, building materials and other possible shelters of adult gnats. The application was made, with the power spraying equipment, at the time when the first adult gnats began to emerge. The shelters were only treated on the outside surfaces as the gnats seldom enter buildings or other structures. The residual was applied on the structures from the surface of the ground to about four feet above, as it was observed that most of the gnats remain near the ground on these shelters. The surfaces were thoroughly wet with the spray in the same manner used for fly and mosquito residual control. This residual treatment apparently destroyed the gnats seeking shelter on these structures as none were observed remaining on these treated surfaces.

Smoke Aerosol.

A smoke aerosol consisting of 7½% DDT in fuel oil was used when necessary to destroy adult gnats. It was produced by the thermol aerosol smoke generator on the exhaust of the Dodge truck. The smoke produced by this method was found to be very effective in killing adult gnats when climatic conditions were favorable. This aerosol was used occasionally from the latter part of April until the end of May. It was used effectively on areas where there was a report, or even a suspicion, of the presence of gnats. The results were immediate but the effects were temporary, lasting for only a few hours. This spectacular control measure had an excellent psychological effect on employees.

RESULTS OF CONTROL MEASURES

Control of Immature Stages.

The numbers of larvae and pupae present in the soil in a given area were

determined by counting the numbers present in uniform soil samples taken from the area. After treatment of 1 lb. of DDT per acre of the 250 acres in which gnats were found developing, samples were taken at different intervals from different parts of the treated area. The numbers of living and dead larvae and pupae from these samples were determined and compared with counts taken from samples from the same area before treatment. It was determined by this method that the overall kill of larvae and pupae as a result of ground treatment was about 90%.

Collecting Traps.

In addition to soil sampling, gnat production in a given area from treated and untreated ground was determined by collecting the adults in traps as they emerged. The traps were rectangular boxes 18" x 24" and 8" high. The tops were covered with heavy black cloth, the bottoms open to the soil. In one end of the traps small holes were made in which the neck of a 12 oz. bottle, partially filled with water, was securely fastened. As the gnats emerged from the ground covered by the darkened trap they attempted to escape through the hole where the bottle was attached. Upon entering the bottle they were eventually drowned. In this manner they were secured in the water within the bottle where they were available for counting.

The results obtained from one trap operated on an untreated area and the average of three traps operated under typical conditions on the area treated for control are given in Table 2.

The above table shows by comparison the difference in the number of gnats that emerged from the treated and untreated area. It is noted that the percentage of kill gradually decreased from 94% to 16% as the season progressed. It is also evident that the number of gnats emerging has a corresponding decrease. The correlation between the two would indicate about a 90% kill for the season over the entire area treated. The above table is also indicative of the seasonal emergence of these gnats showing a single brood within a short period of time. It likewise tends to substantiate the use of 1 lb. of DDT per acre as a suitable amount for soil treatment and also emphasizes the importance of selecting the proper time for application of this insecticide.

Table 2. Trap Records

Dates of Collection	*Total Emerged Untreated Area*	*Average of Three Traps on Treated Area*	*Percentage Kill*
April			
20–23	18	0 (no traps)	0
24–27	3896	234	94%
28–29	673	74	89%
30–May 1	362	65	82%
2–3	325	67	79%
4–5	130	38	69%
6–7	75	15	80%
8–9	126	40	68%
10–11	62	30	52%
12–13	25	17	32%
14–15	0	0	0
16–17	0	0	0
18–19	12	9	25%
20–21	0	0	0
22–23	0	0	0
24–25	6	5	16%
26–27	0	0	0
	5710	594	

No more gnats emerged after this date.

Results from additional traps operated throughout the season over experimental plots that had been treated are presented in Table 3.

Table 3. Trap Records

1 lb. DDT.	*Adults emerged*
10 gals. water	127
25 " "	85
50 " "	92
1 lb. BHC 25 gals. water	769

It is evident that emergence of adults on experimental plots where 1 lb. of DDT per acre was used was much lower than the average from the three traps operated on the controlled area as shown in Table 2. This was undoubtedly due in part to the care and uniformity with which the insecticide was applied to the experimental plots. The much higher number of gnats

emerging from the experimental plot treated with BHC was the result, as explained previously, of the BHC losing its lethal effect more rapidly than DDT as the season progressed.

Observations.

Careful observations were made from about April 20 to May 28, the period in 1949 when the adult gnats were on the wing, to determine the effectiveness of the control program. Adult gnats were collected whenever they appeared. Workmen were questioned daily about annoyance from gnats. Company officials were requested to report any gnats called to their attention. Residents in the area were asked to comment on the gnat situation as compared with previous seasons. All information obtained in this manner proved the control program to be very effective. The control work reduced the number of gnats in the area to such an extent that no noticeable annoyance was reported by workmen or company officials. Long residents of the area stated it was the first spring they could remember when gnats had not been annoying in North Salt Lake City.

Summary and Conclusions

As the result of a survey it was determined that approximately 250 acres of ground comprised the area in which the gnats were developing in North Salt Lake City during the spring of 1949. As a result of experimental investigation 1 lb. of DDT in 28 gallons of solution per acre was used to treat this area in an attempt to destroy the gnat larvae and pupae. The insecticide was applied with ground equipment at the time when most of the gnat larvae were concentrated in the top quarter inch of soil and at the time pupae were beginning to appear on the surface of the ground. This treatment produced about a 90% overall kill of larvae and pupae.

Five percent DDT was used effectively on adults as a residual applied to buildings and other resting shelters used by the gnats. Thermal smoke aerosol consisting of 7½% DDT emulsion in fuel oil was used to destroy adult gnats in areas where men were working. This aerosol provided immediate local but only temporary relief from gnat annoyance.

The gnat control work conducted in North Salt Lake City during 1949 was practical and successful. The control work will undoubtedly be improved as the result of practical experience and field experiments now in progress.

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SOME PERSONAL OBSERVATIONS ON THE TREATMENT OF CLEAR LAKE, CALIFORNIA FOR THE CONTROL OF THE CLEAR LAKE GNAT

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I had the good fortune on September 15 and 16, 1949, to witness the treatment of Clear Lake in California, for the control of the Clear Lake gnat (*Chaoborus astictopus* Dyar and Shannon). Without doubt, this operation together with the research leading to the final operation, was among the most unique ever carried out in the field of entomology.

This is not a scientific report of the research or of the control procedure. It is, rather, a brief popular account of this unusual insect control program.

The Clear Lake gnat problem is strictly a local one confined to Lake County, California. During summer months on warm calm evenings, the gnats are on the wing in countless millions. They create a serious nuisance in many ways by sheer weight of numbers. They are strongly attracted to lights. Homes are invaded. They smear windshields on cars. They plug car radiators. They make any function unpleasant, either indoors or outdoors, by contaminating foods. Their presence in such huge numbers creates a favorable situation for spiders; practically everything becomes encased in a veil of spider webs. The gnats constitute a health problem, I am told, because a number of local people have developed allergies to them.

This otherwise wonderful recreational area could not develop to its maximum potential because of the gnat nuisance. It is believed, and I think rightly, that gnat abundance at Clear Lake is the only reason people from near-by metropolitan areas do not take full advantage of this splendid recreational area. The people of Clear Lake are naturally anxious to control the gnat, not only to relieve a personal nuisance, but also with the hope that the area will develop from a financial standpoint.

A great deal of research has gone into the Clear Lake gnat problem. In the early thirties research was undertaken by the University of California. Basic information on the gnat's biology was obtained, and possibilities of utilizing light traps were also studied as a control measure.

Congress appropriated funds to the Bureau of Entomology and Plant Quarantine in 1938 to study the biology and control of the gnat. This work was undertaken by the Division of Insects Affecting Man and Animals, then headed by Dr. F. C. Bishopp.

Mr. A. W. Lindquist was placed in charge of the research station located at Clear Lake. He was assisted by Dr. C. C. Deonier. Intensive studies were undertaken on the life history, habits, ecology, and possible control measures during 1938 to 1942. Valuable scientific information was obtained, not only about the gnat itself but also with regard to other forms of aquatic life including fish. All promising control measures were explored. Among these were light traps and burning of gasoline in areas where the eggs of the gnat had accumulated, usually along the shore line. No control program was initiated, however. During the war the work was discontinued and the personnel were assigned to the Bureau's laboratory at Orlando, Florida, for research on other problems then demanding solution.

In 1946 Mr. Lindquist was placed in charge of the Corvallis, Oregon, laboratory of the Bureau. Fortified with the vast amount of experience he had gained at Orlando in research on mosquitoes and other problems involving the use of new insecticides, he undertook exploratory

studies to determine if the gnat larvae or adults might be controlled with the new chemicals. It was difficult to carry out a research program at Clear Lake from Corvallis headquarters. Nevertheless, through a series of brief trips, he and his assistants demonstrated, by laboratory tests, that the application of certain chemicals offered exceptional promise as a control measure for the gnat larvae. DDT was among the most effective of the new materials when used at dosages as low as 1 part to 100 million parts of water. TDE appeared equally outstanding.

The primary unanswered questions were (1) Will treatment of a lake with these insecticides kill the gnat larvae? (2) Will control be obtained without killing fish?

Various formulations of DDT and TDE were then tested against gnat larvae under different conditions. The California Fish and Game Department cooperated by testing the formulations against fish. Finally it was decided that TDE applied as an emulsion concentrate offered most promise from both the standpoint of larvicidal efficiency and safety to fish. A small lake of about 75 acres near Clear Lake was selected for a "pilot plant" test, in December 1947. Mr. Lindquist and Mr. Roth of the Corvallis laboratory applied the treatment at the rate of 1 part of TDE to 45,000,000 parts of water. Mr. Garth Murphy of the California State Fish and Game Department studied the effects of the treatment on fish directly and also studied the important question of possible long range effects of the treatment on fish due to destruction of aquatic life consumed as food by fish.

The experiment was considered a success. Complete control of the gnat larvae was attained after about one month. A few fish were killed, however. Death of the few fish was attributed largely to improper dispersion of the emulsion in the water.

To be certain, however, a second test was made in 1948 in another small lake. TDE was applied at the rate of 1 part of TDE to 75 million parts of water. Complete control of the gnat larvae was attained in this test without apparent harmful effects on the fish.

Residents of Lake County, California were greatly interested in the progress of these experiments. They cooperated in every possible way and supported the work by meeting a part of the expenses of the research program. They organized a gnat and mosquito abatement district under the laws of the State of California. Then the County appropriated funds for a program to treat big Clear Lake. The Bureau of Vector Control of the California State Health Department, allocated part of the funds and cooperated in other ways.

When residents of Lake County showed determination to go through with a program to treat Clear Lake, Mr. Lindquist told them that according to the experimental results a successful program might be possible. He advised the County Supervisors and the abatement organization, however, that a venture of this type represented a long jump from treating a lake of 50 acres to treating one of 40,000 acres. No one could be sure, he explained, that the treatment would be a success but he offered to assist in every way possible, and agreed to provide necessary technical supervision in planning and carrying out the program. The county officials consulted with California State game specialists and Mr. Murphy was assigned to assist and to observe the effects of the insecticidal application on fish. The many details of arranging the program were carried out by Lake County residents. Tom Garner, County Clerk, Mr. Hitchcock, Chairman of the County Supervisors, J. K. Peterson, and many others did an excellent job in arranging all the details of the general plan which Mr. Lindquist proposed to them.

The program was carried out in every way according to plan. The actual treatment of the lake was made in an excellent manner.

The date for making the treatment was set for September 15, 1949. At dawn that

day six tugs, each pulling barges loaded with drums of TDE emulsion base containing 30 percent of TDE, 10 percent of Triton x-100 and 60 percent of xylene, were on their way to the respective sections of the lake assigned to them for treatment. See figure 1.

The emulsion concentrate was applied undiluted to the water through a small hose by gravity feed. It was applied in the wake of the barges as shown in figure 2 in order to obtain efficient emulsification in the water. The rate of delivery had been calculated beforehand, taking into account the speed of the tugs, the average depth of the water, and width of "swath." The desired rate of application was 1 part of TDE to 75,000,000 parts of water. The schedule called for completion of the treatment in two days, which necessitated distributing 14,000 gallons of insecticide concentrate.

The enthusiasm of the people of Lake County was the real highlight of the occasion. This operation was not an experiment in any way to them—it meant the end of the Clear Lake gnat. They designated the date of the treatment as "G E day"—G E, meaning "Gnat Eradication." A replica of the gnat, 4 feet long (Figure 3) was constructed by the local undertaker. The effigy was called "G. Nat." It was placed in a coffin on the Court House lawn where it lay in state for several days prior to its disposition for all to "mourn." (Figure 3)

Every resident of the county apparently was present on the night of September 15

FIG. 1.—A tug towing a barge loaded with drums of TDE emulsion concentrate. The tug and barge are *en route* to the sector of the lake where material was applied.

FIG. 2.—Emulsion concentrate draining by gravity into water where turbulence created by movement of barge results in emulsification.

FIG. 3.—Effigy of "G. Nat" lying in state for ceremony celebrating death of the gnats.

to pay final tribute to Mr. G. Nat. A number of notables were present, and a clever, well prepared eulogy was delivered by Mr. Crump, a local attorney. This was followed by a song about the gnat, written by another Lake County resident. It was sung to the tune of "We'll be glad when you are dead—you rascal you."

Following the ceremony, "G Nat" was placed on a bier in the lake and burned.

The celebration was certainly premature to those of us who know about the many disappointments that can occur in the best planned control projects, especially in new ones. I am sure all entomologists present, especially Mr. Lindquist, felt serious responsibility in developing this program, and he, more than anyone else realized how disappointed the people would be if the program failed to accomplish the objective.

The results of the treatment are being reported more fully by Mr. Lindquist and his associates, and by Garth Murphy, Arve Dahl (Bureau of Vector Control of California) and others. Although at this writing it is too early to estimate the success of the program, it can be stated that a good share of the estimated 714,000,000,000 gnat larvae (Mr. Lindquist's figure) in Clear Lake were dead within 48 hours after the treatment was applied.

Entomologists know that eradication means 100 percent kill, and they realize that if even one percent of a species survives it may be only a short time before the original numbers are back again. Nevertheless, we hope the treatment undertaken will mean relief from the gnat to residents of Lake County for at least a year. If so, in my opinion, the program will have been a great success.

FIELD NOTES ON MOSQUITOES COLLECTED IN LIBERIA, WEST AFRICA*

BY

M. S. BRISCOE

The coast of Liberia is characterized by many tidal lagoons and creeks which are fringed with mangrove trees *(Rhizophora mucronata)*. The land around the coastal towns and villages is low and swampy. Secondary vegetation is dominant since most of the land has been cleared of virgin forests.

Mixed forested regions prevail in the hinterland. Here, the land is marked with rolling hills and low mountains. Streams, which are fed by the heavy rainfall, are numerous. This water is usually clear and potable. There are no extensive ponds; swamps, however, are encountered frequently.

The rainy season begins in April and terminates in November. The rains are torrential and the total annual rainfall is usually more than 170 inches. During the wet season the trails are inundated and the narrow streams are considerably swollen.

Although there is a dry period, no month on the coast is entirely free from rain. As a rule, January and February are the driest months.

Due to the geographical position of Liberia, (4° 22′ to 8° 50′ north latitude, and 7° 33′ to 11° 32′ longitude west of Greenwich), the climate is equatorial. Humidity in the hinterland, however, is much less than that on the coast.

While stationed in Liberia (1943 to 1945) I had the opportunity to make brief reconnaissance collections of mosquitoes

*A contribution from the Department of Biology, The Catholic University of America, Washington, D. C.

on the coast and in the hinterland both during the rainy and dry seasons. A list of the specimens, together with field notes and localities, follows:

Anopheles funestus Giles. Roberts Field; Harbel; Gbanga. Larvae were collected from drainage ditches, shady margins of ponds and bodies of clear water. In some instances both *funestus* and *gambiae* were found in the same breeding sites. There was a tendency for the larvae to remain away from the surface of the water a long time when disturbed.

Adults were collected in native huts which were made of mud-wattled walls, leaf-thatched roofs and dirt floors; a few were constructed of grass. These mosquitoes are domestic and essentially androphilous.

Anopheles gambiae Giles. Roberts Field; Harbel; Owen's Grove; Marshall; Fisherman's Lake; Reputa; Salala; Cape Palmas; Grand Bassa. Larvae were taken from rice fields, shallow wells, edges of swamps, drainage ditches, irrigation ditches and such temporary water collections as road ruts and small depressions made by native footprints. During the rainy season *gambiae* was found breeding almost everywhere except in fast-running water and pools covered with vegetation.

The majority of mosquitoes captured in native dwellings were *Anopheles gambiae*. The huts were poorly ventilated and the interior was usually very dark since many of them did not have windows. Favorite resting places were the walls, low ceilings, rags hanging on the walls and grass mats suspended from rafters. Captured females were usually engorged with blood. Many adults were also captured in stable traps having humans as bait.

Gambiae was the most domestic anopheline encountered. It is intensely anthropophilic. Its appetite for human blood and habit of resting indoors are causative factors in outbreaks of epidemic malaria. Developing larvae of *Wuchereria bancrofti* were found in the thoracic muscles of many of these mosquitoes. Occasionally, an infective filariform larva was dissected from the proboscis.

Anopheles hancocki Edw. Roberts Field; Harbel; Fisherman's Lake. Breeding sites of this mosquito were shallow native wells, vegetated pools, drainage ditches and swamps. Although adults are known to frequent human habitations, inspection of native quarters failed to reveal a high density.

Anopheles nili (Theob.) Roberts Field; Harbel. Larvae were most generally encountered in dense shaded situations along the margins of running streams. Only a few adults were collected; these were taken in native huts.

Anopheles paludis Theob. New record for Liberia. Roberts Field. Larvae were collected in swampy areas. These situations were densely shaded and associated with aquatic vegetation. Adults were captured in a stable trap; none, however, were found in native dwellings.

Aëdes (Aëdimorphus) sp. very close to *filis* I. & M. Roberts Field. The larvae were found during the rainy season in temporary water collections. Adults were never taken in native quarters.

Aëdes aegypti (L.). Roberts Field; Harbel; Kakata; Monrovia. The larvae of this species were found mainly in bamboo stumps, leaf axils, tree holes, wells and tin cans. Only a few centimeters of water were necessary. In Kakata and Monrovia anophelines and *aegypti* were breeding in open wells. Adults were not found far from their place of emergence. Only a few were taken indoors.

Aëdes africanus (Theob.). Roberts Field; Kakata. During the wet season breeding occurred in holes of cut tree trunks in which rain water had accumulated. In some instances these larvae were associated with those of *aegypti*. Two adults were found in a stable trap; a few were taken in native huts.

Aëdes luteocephalus Newst. Roberts Field. A few larvae were found during the rainy season in temporary pools. Two adults were collected in an abandoned wooden building near the breeding sites.

Aëdes vittatus (Bigot). Roberts Field. Open ditches in forest clearing yielded larvae of this species. A few adults were taken in a stable trap.

Culex annulirostris consimilis Newst. Roberts Field; Harbel. Larvae of this species were found in temporary puddles in forest clearings exposed to the sun. They were in association with *A. gambiae*. Adults were not observed in native dwellings.

Culex bitaeniorhynchus Giles. Roberts Field; Harbel. Larvae were found in rice fields, ditches and hollow tree stumps during the wet season. Adults were not taken in native quarters.

Culex guiarti Blanch. Roberts Field; Harbel. Larvae occurred in temporary ground pools in forest clearing. The few adults collected were in an abandoned wooden building near the breeding sites.

Culex moucheti Evans. Roberts Field; Harbel. During the dry season larvae of this species were taken from the quiescent margin of permanent pools. In the wet season they were found in three stumps where rain water had accumulated. Adults were taken from an abandoned wooden building; a few were found in a stable trap.

Culex nebulosus Theob. Roberts Field; Harbel. Many larvae were taken during the wet period from tree stumps and felled giant silk cotton trees *(Ceiba pentandra)* which had been partly hollowed out by natives in the process of making canoes. Adults were captured on foliage near the breeding places.

Culex tigripes Gr. & Ch. Roberts Field; Harbel. Breeding sites for this species were holes in fallen trees and the axils of banana leaves. They were also found breeding in containers near human habitations. The larvae are predaceous. None of the adults were found in native huts.

Eretmapodites chrysogaster Graham. Roberts Field; Harbel. Many larvae of this species were found in the axils of banana leaves and hollow stumps of bamboos partly filled with rain water. They are predaceous. Adults were never seen in native huts.

Mansonia africana (Theob.). Roberts Field; Harbel. The larvae were associated with vegetation in ponds and swamps. They possess a saw-toothed siphon with which they puncture the air tubes of aquatic plants. Adults were captured in stable traps and native dwellings.

Mansonia metallica (Theob.). Roberts Field. The breeding habits are similar to those of *M. africana*. A few adults were captured in a stable trap.

Mansonia uniformis (Theob.). Roberts Field. The breeding habits are similar to those of *M. africana*. Many adults were taken in native huts. They were found on clothing hanging on the wall and grass mats suspended from rafters. A few were caught in a stable trap.

Megarhinus sp. probably *brevipalpis conradti* Grünb. Roberts Field; Harbel. The larvae of this species are predaceous. Many were found in hollow stumps partially filled with rain water. In some instances they were associated with the larvae of *Eretmapodites chrysogaster*. Adults were not found in native huts.

Ficalbia (Miomyia) sp. Roberts Field. A few larvae were taken from vegetated pools. Adults, however, were not observed in native quarters.

Acknowledgments

The writer is indebted to Dr. Alan Stone, Bureau of Entomology and Plant Quarantine, for determining the specimens.

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OBSERVATIONS ON MOSQUITO AND MALARIA CONTROL IN THE CARIBBEAN AREA

PART 5 [1] — VENEZUELA

H. H. STAGE [2] AND ARTURO LUIS BERTI [3]

While attending the Fourth Pan-American Malaria Conference in Maracay, Venezuela, in January 1947 the senior author had the good fortune to observe the extensive malaria program under way in that country. It is apparent that progress in malaria control throughout the world has reached its peak in Venezuela, both in expenditure per capita and broadness of the program. The approximate cost of the 1947 program was $2,500,000, or between 50 and 60 cents per capita. The total number of employees was about 1,200, including 31 DDT crews with from 7 to 9 men in each. In 1947 these crews treated regularly 87,238 houses (Fig. 1) in the States of Apure, Barinas, Bolivar, Sucre, Monagas, Anzoategui, Guarico, Miranda, Aragua, Carabobo, Yaracuy, Lara, Cojedes, Portuguesa, Trujillo, Zulia, and Territorio Amazonas (Fig. 3).

The Division de Malariología dates from 1935. Its remarkable growth and efficiency are due in no small measure to its able and energetic director, Arnoldo Gabaldon. Fortunately, he has had the excellent support of A. Arreaza Guzman, Director de Salubridad Pública; and Edmundo Fernandez, Ministro de Sanidad y Asistencia Social.

From 1931 to 1935, before the program was initiated, there were approximately 500,000 to 1,000,000 cases of malaria annually. Free treatments given to the public dropped from 817,115 at 1,072 posts of distribution in 1943 to 487,833 at 2,449 posts in 1947. This drop in the demand for medication indicated a proportional drop in the number of malaria cases.

Organization and Program of the Division de Malariologiá.—The effective program for malaria control includes a school of malariology (Fig. 2), which gives three separate courses of study. The first course is a popular one giving some of the basic principles of malaria control to persons having the equivalent of a sixth-grade education. The second course is more intensive, and is designed for subinspectors. The third course is an advanced one for physicians, engineers, and inspectors.

Most of the subprofessional personnel in the Division have passed the first two courses, and have had enough field experience to give them a well-rounded understanding of the disease and the problems involved. Malaria control is being taught in the schools and broadcast over the radio, and thousands of informational leaflets are being distributed to publicize the program.

After DDT became available, an additional four-weeks' training course on residual spraying was initiated. The newly assigned chiefs of the DDT crews are required to spend 12 weeks as assistants to those who have had the required training and experience.

The Venezuelan Government offers annually one scholarship to each of the twenty countries comprising North and South America. Physicians, engineers, and others engaged in malaria control work are eligible. The scholarships provide $180 a month, with $100 a month additional for traveling expenses during the last two months of the course. These sums

[1] Parts 1, 2, and 3 have already appeared; part 4 will appear in a subsequent issue. Exigencies of space have dictated changing the order of publication of parts 4 and 5.

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Figure 1. Houses sprayed with DDT are identified with symbols. The figure 100 represents the order in which the house was sprayed; the dash (1 or more) the number of sprays the house has received during the year.

Figure 2. Air view of the Division de Malariologia, Maracay, Aragua, Venezuela.

cover the expenses of the student for room and meals.

Manuals of procedures which have been prepared for most of the activities pertaining to malaria control are now in use.

Antimalaria activities:—The engineering activities of the Division for the Control of Malaria include the forestation of swampy areas with eucalyptus and other trees; the paving of ditches totaling more than 278 kilometers (172 miles) in some 30 towns; the filling in of swampy areas; and other comparable measures.

A laboratory for testing the materials

FIG. 3. Map of Venezuela.

used in paving ditches was installed in 1946. Here Panama inverts, pipes, half pipes, and other concrete structures are tested with a Universal Testing Machine of 200,000 pounds capacity.

Antimalaria Drugs:—Various antimalaria drugs were distributed without charge in schools, post offices, telegraph offices, and other places readily accessible to the public. In 1946, for example, 575,839 doses of metoquina (quinacrina) were distributed under this program. Several villages were selected for testing chloroquine. Preliminary reports show satisfactory reduction of malaria by this means.

Control of Anopheles Mosquitoes:—Until DDT became available late in 1945 to control *Anopheles* mosquitoes, oil and paris green were the only larvicides used. The present plan is to use DDT residual sprays on practically all rural homes in northern Venezuela wherever malaria is a problem.

Cooperation with International Health Division of the Rockefeller Foundation:—Special mention should be made of the cooperation between the International Health Division of the Rockefeller Foundation and the Division de Malariología. A Section of Special Studies of the Foundation is studying the use of DDT in the field in order to lower the cost of application and to study and appraise the influence that spraying of houses with DDT may have on the general health and welfare of the people. This section is also examining the blood protozoa of local

birds, reptiles, and bats, and is continuing taxonomic studies, which have been under way for a number of years.

Species of *Anopheles* in Venezuela.—The principal vectors of malaria in Venezuela are *Anopheles albimanus* Wied. on the coast and *A. darlingi* Root in the interior. The other anophelines, according to Dr. Pablo Cova-Garcia, are *A. argyritarsis,* R.-D., *A. pseudopunctipennis* Theob., *A. punctimacula* D. and K., *A. mattogrossensis* L. and N., *A. eiseni* Coq., *A. albitarsis* L.-A., *A. strodei* Root, *A. bellator* D. and K., *A. peryassui* D. and K., *A. neomaculipalpus* Curry, *A. kompi* Edw., *A. oswaldoi* Pery., *A. pessoai* G. and L., *A. boliviensis* Theob., *A. nimbus* (Theob.), *A. aquasalis* Curry, *A. rangeli,* G., C.-G., and L., *A. nuñeztovari* Gab., *A. benarrochi* G., C.-G., and L., *A. vargasi* G., C.-G., and L., *A. homunculus* Komp, *A. parvus* (Chagas), *A. thomasi* Shan., *A. mediopunctatus* (Theob.), *A. apicimacula* D. and K., *A. cruzii* D. and K., *A. triannulatus davisi* P. and S., and *Chagasia bathanus* (Dyar).

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ADDITIONAL STUDIES ON THE LARVAE OF *Uranotaenia syntheta* DYAR AND SHANNON (DIPTERA: CULICIDAE) [1]

OSMOND P. BRELAND [2]
The University of Texas

The adult of this mosquito was described in 1924 from a female specimen reared from a larva collected at Mission, Texas (Dyar and Shannon 1924). Dampf (1943) described the male, and published observations relative to the biology and distribution of the species in Mexico. In 1946 the larva was described from a specimen collected at Fort Worth, Texas (Porter 1946).

During the past two years, the writer and his associates have collected many larvae of *Uranotaenia syntheta,* and have reared some to adults, thereby correlating adult and larval stages. A few notes relative to the status of *U. syntheta,* and some observations on biology have recently been published (Breland 1948).

The original larval description was made from a single specimen, and consequently it was not possible to note individual variations that might occur in a series of larvae. For this reason, it has seemed advisable to study many larvae so that these variations may be noted. The following description is based upon a study of several dozen larvae collected over a period of two years from Palmetto State Park

[1] Supported by the University of Texas Research Institute.

[2] The writer wishes to express his appreciation to Mr. John E. Porter and Dr. H. H. Ross of the Illinois Natural History Survey, who allowed him to examine the larva from which the original description was made. Mr. Porter has kindly informed the writer that he is no longer in the area where the species occurs, and that he therefore welcomes additional studies by other workers. The suggestions of Dr. Alan Stone regarding distinguishing features of the larvae of *Uranotaenia* are greatly appreciated. The writer is grateful to Miss Lucille Hagan who made the drawings.

near Luling, Texas, as well as a study of the larva from which the original description was made. The terminology used is that of Carpenter, Middlekauf and Chamberlain (1946).

DESCRIPTION OF LARVA *of Uranotaenia syntheta*

HEAD only slightly longer than wide, not obviously so, as in some other species of *Uranotaenia;* darkly pigmented except in region of the eyes. ANTENNA about ¼ length of head with a few coarse spines on the shaft, and several papillae at the tip. Antennal hair single, small, inserted medially near basal third of shaft. HEAD HAIRS: PREANTENNAL multiple, sparsely barbed, about same length as antenna; LOWER single, coarse, sparsely barbed, longer than antenna; UPPER usually double, coarse, shorter than lower; single and forked near tip in an occasional specimen. POSTCLYPEAL 4 to 5-branched, shorter than upper and lower. SUTURAL usually single and forked near middle, sometimes single or single and forked near tip. TRANSUTURAL multiple and long.

DORSAL SUBMEDIAN PROTHORACIC HAIR GROUP composed of two long single barbed hairs extending beyond the bases of upper head hairs, and a multiple tuft of 5 to 6 slightly shorter hairs also barbed.

ABDOMEN: UPPER LATERAL ABDOMINAL HAIRS double on segments 1 and 2; LOWER single on segment 1 and a short multiple tuft on segment 2. COMB of 8th segment composed of 7 to 10 scales on the posterior margin of a large sclerotized plate. Individual scale thorn-shaped, with small lateral spinules visible under high-power on basal half to two-thirds. Groups of small spinules on plate near bases of comb scales. Part of plate to which comb scales are attached frequently projecting more posteriorly than remainder of plate. SIPHONAL HAIR multiple, smooth, attached to a small sclerotic area; a single smooth hair between siphonal and subsiphonal attached to same plate as siphonal. SUBSIPHONAL HAIR multiple, sparsely barbed, attached to a small sclerotic plate; a single smooth hair between subsiphonal and anal hair, not arising from a sclerotic area. ANAL HAIR multiple, smooth, no sclerotic area occurring at base. SIPHON about 4½ to 5 times as long as basal width. PECTEN of numerous evenly spaced teeth reaching near middle of siphon. Individual pecten tooth broad, fringed with fine spinules visible under high-power. SUBVENTRAL TUFT multiple, barbed, inserted at or slightly beyond end of pectin. DORSAL BRUSH of a long lower double tuft, and a shorter upper tuft with usually 3 hairs on each side. VENTRAL BRUSH rather sparse, some of the posterior hairs 4- or 5-branched. ANAL SEGMENT longer than wide, completely ringed by plate. Posterior edge of plate set with small spinules. LATERAL HAIR multiple. GILLS 4, slightly pointed, usually somewhat shorter than anal segment.

In most generic keys now in use for larvae of mosquitoes in the United States, larvae of the genus *Uranotaenia* are distinguished from other larvae by the structure of the head hairs and the shape of the head. *Uranotaenia sapphirina* (Osten Sacken), *U. lowii* Theobald and *U. syntheta* Dyar and Shannon are the only species of *Uranotaenia* known to occur in the southwestern United States. In the two former species, both the upper and lower head hairs are single and spinelike, while the head is longer than wide. In most other culicine larvae, the head hairs are hairlike, frequently branched and the head is not obviously longer than wide. Consequently, the head hairs and the shape of the head are sufficient to distinguish *U. sapphirina* and *U. lowii* from the larvae of other culicine genera. In the larvae of *U. syntheta,* however, the head hairs are not obviously spinelike, the upper head hairs are usually double and in most specimens the head is not noticeably longer than wide.

It is thus proposed that future generic larval keys for mosquitoes of the southwestern United States, or for the United States as a whole, be modified to include distinguishing features of *U. syntheta.* At

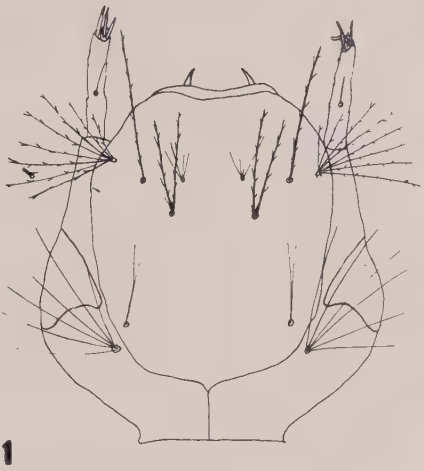

Fig. 1.—Head of fourth instar larva of *Uranotaenia syntheta* Dyar and Shannon.

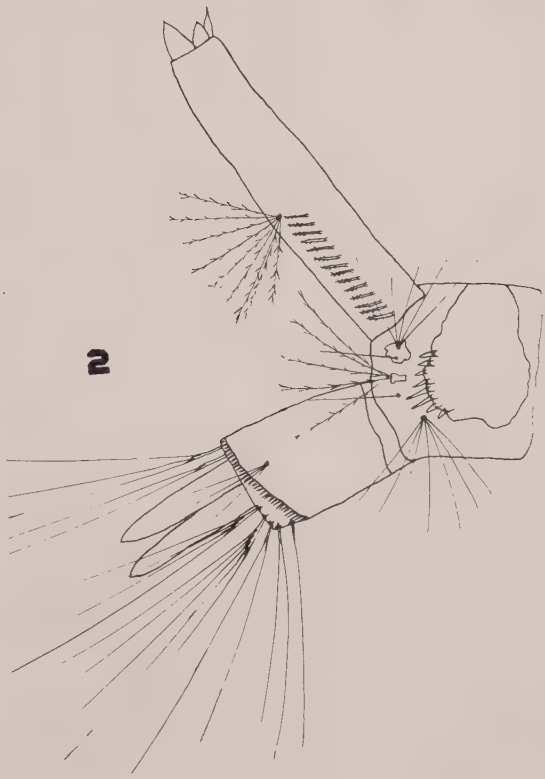

Fig. 2.—Terminal segments of fourth instar larva of *Uranotaenia syntheta* Dyar and Shannon.

this writing, *U. syntheta* has been collected in the United States only from Texas, but future collections may reveal that the species occurs in adjacent states. In the larvae of the genus *Uranotaenia* known to occur in the United States, the comb scales on each side are attached to the posterior edge of a large chitinous plate. The comb scales of most other culicine larvae in this region occur as a row or patch of individual scales. The larvae of some species of *Psorophora* are exceptions in that their comb scales are attached to a small plate. This plate in these *Psorophora* larvae, however, is quite small, and it covers much less than one half of the lateral surface of the segment. In the larvae of *Uranotaenia,* the plate is large and conspicuous; it covers more than half the lateral segmental surface and sometimes extends dorsally to the upper side of the segment. It appears, therefore, that the differences in the comb scales are better key characteristics than the shape of the head and the structure of the head hairs.

Once the larvae of *U. syntheta* are determined to genus, they may be distinguished easily from other larvae of *Uranotaenia* known to occur in the same area. In *U. sapphirina* and *U. lowii* the upper and lower head hairs are large, single and spinelike. These hairs are much smaller in *U. syntheta* and the upper head hairs are double or forked on one or both sides.

The larvae of *U. syntheta* are apparently very similar to those of *U. anhydor* Dyar, a rare species known only from the vicinity of San Diego, California. At the present state of our knowledge it is not possible to give morphological features that will distinguish the larvae of the two species. However, in view of the distance now known to separate the two mosquitoes, it does not appear probable that the ranges overlap. Distinctions may thus be made on the basis of distribution.

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MORPHOLOGICAL NOTES ON *ANOPHELES AQUASALIS* CURRY AND *ANOPHELES OSWALDOI* PERYASSÚ [1]

W. G. DOWNS, M.D.

In 1941–1942, during malaria studies in Trinidad, British West Indies, detailed observations were made of male terminalia of *Anopheles (Nyssorhynchus) oswaldoi* Peryassú 1922 and *Anopheles (Nyssorhynchus) aquasalis* Curry 1932.

Methods

Adult males of the oswaldoi species were easily and rapidly separated from those of the aquasalis species on the basis of the amount of black on the second hind tarsal segment: In the former species this segment is about one-sixth black; in the latter it is about one-half black. There were no other members of the "Tarsimaculatus complex" present. Routine dissections of the male terminalia were carried out; the mesosome, fused ventral lobes and ninth tergite were separated in each case for more detailed study. The specific morphological details considered included:

Mesosome: the length and width of the membranous portion of the tip, and the presence or absence of spines.

Fused ventral lobes: the length of hairs at the distal free margins of the basal lobules, the appearance of the "preapical plate," and the shape of the apex of the outer lobes.

Ninth tergite, small median bilobed process: this is constant in *oswaldoi* and absent or very small in *aquasalis*.

Specimens were examined while fresh, and notes and sketches were made. Specimens were then mounted in polyvinyl-lacto-phenol (1). It is worthy of note that many of the preparations so mounted in 1941 were still in excellent condition in 1948.

The aid and advice of the late Mr. R. C. Shannon were of great value in the execution of the work.

Observations

The *oswaldoi* and *aquasalis* of Trinidad correspond closely with published descriptions of these species (2,3); only minor inconstant variations were encountered. It was observed that a considerable number of the *oswaldoi* had short, sharp spines on the mesosome; and this point was investigated in detail, as it was at first thought that the varient might be a distinct species. Careful search was made for spines on the mesosomes of *aquasalis*, but none were ever encountered.

The tabulation below summarizes the results of observations on collections of *oswaldoi* and *aquasalis* with regard to the presence or absence of spines on the mesosome.

Species	No. of Collections	No. of Specimens without Spines	No. of Specimens with Spines
A. aquasalis	35	61	0
A. oswaldoi	21	33	0
A. oswaldoi	7	0	7
A. oswaldoi	8	14	10

It is seen that in some collections of *oswaldoi*, only specimens without spines were encountered in others, only specimens with spines; while in eight collections specimens with and specimens without spines were present (see figs. 1–6).

In order to study this point further, female *oswaldoi* that had taken blood meals were caged. Their eggs were collected, and the progeny were reared. From the eggs of one *oswaldoi* from Sangre

[1] The studies and observations on which this paper is based were conducted with the support and under the auspices of the Medical Services of the Crown Colony of Trinidad and Tobago, British West Indies, and the International Health Division of The Rockefeller Foundation.

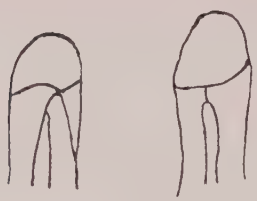

FIG. 1 FIG. 2

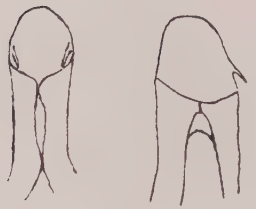

FIG. 3 FIG. 4

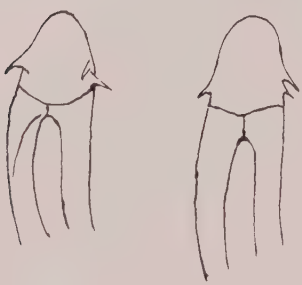

FIG. 5 FIG. 6

FIG. 1. Mesosome of *Anopheles aquasalis;* FIG. 2, Mesosome of *Anopheles oswaldoi;* FIG. 3, Mesosome of *Anopheles oswaldoi* with spines (Coll. 414, No. 2); FIG. 4, Mesosome of *Anopheles oswaldoi* with spine (Coll. 539, No. 3); FIG. 5, Mesosome of *Anopheles oswaldoi* with one spine on one side and two spines on the other side (Oviposition 43–44, No. 3); FIG. 6, Same as Fig. 5. Freehand drawing made before preparation of permanent mount.

All sketches except Fig. 6 were made with camera lucida, magnification 1800x.

Specimens have been deposited with Dr. Lloyd E. Rozeboom, the Johns Hopkins School of Hygiene and Public Health, Baltimore, Maryland.

Grande (E-34) 10 males were obtained, eight without spines on the mesosome and two with spines. From the mixed oviposition of two *oswaldoi* from Sangre Grande (E-43 and E-44) three males were obtained, all with spines. From eggs of another *oswaldoi* from the same place (E-54) nine males were obtained, eight without spines and one with a spine on one side of the mesosome.

The spines are short and sharply pointed, no more than 8 to 10 microns in length. They were usually found to be bilateral, but occasionally they were unilateral. In one instance a double spine was present on one side of the mesosome and a single spine on the other side. The spines are shown in figs. 3–6.

Summary

The occurrence of small spines on the terminal portion of the mesosome of some specimens of *Anopheles oswaldoi* from Trinidad, B.W.I., is described and illustrated.

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3. COVA-GARCIA, P. 1946. Notas sobre los Anofelinos de Venezuela y su Identificación. Ed. Grafolit, Caracas, Ven., p. 121.

NEWS AND NOTES

Leo Jachowski's friends in the AMCA will be happy to learn of the card he sent from Samoa wishing us a Merry Christmas and a Happy New Year. It was too late to make the December issue (which went to press before November 1); but the news that Leo expects to be "back across the road" (the Naval Medical Research Institute at Bethesda, Md.) in May, is timely for the March issue. H.L.T.

Remember our good friend and contributor from Brazil, Dr. Fernando Bustamante? He has worked for a long time on mosquito control around Rio de Janeiro; and his address is Pereira Bareto 14, Apt. 201, Rio de Janeiro. We extend his greetings received in December of "Boas Festas Feliz Ano Novo." H.L.T.

Dr. Leonard Jan Chwatt of the Yellow Fever Research Institute at Yaba Lagos, Nigeria, is well known to many AMCA members both personally and through his contributions to "Mosquito News." If you turn to page 56 of the June 1949 issue, you will find his article on *Anopheles gambiae;* and if you look at picture no. 5, page 187 of the December 1948 issue, you will find out what he looks like! Mrs. Chwatt wrote to us on January 8, saying that her husband plans to come to the United States in September, and that she will follow in November. The Chwatts are now proud parents of a small son, Andrew John. The AMCA heartily welcomes this newest mosquito fighter, and looks forward to telling Dr. and Mrs. Chwatt so personally in the near future. H.L.T.

The AMCA has a new Canadian member, William E. Beckel, of the Defense Research Board of Canada. Bill visited the mosquito folks in Washington, Beltsville, and Bethesda, during January; and his itinerary called for trips to Savannah and to Orlando. He was particularly interested in observing techniques and procedures for rearing mosquitoes under laboratory conditions; and he will attempt to make use of this information in investigating Canadian mosquitoes up around the Arctic Circle. He expects to study the ecology, physiology, and oviposition requirements of *Aedes punctor, A. communis, A. nigripes,* and *A. nearcticus.* His address is: William E. Beckel, Defense Research Northern Laboratories, Fort Churchill, Manitoba, M.P.O. 1015. H.L.T.

Mr. Thomas D. Mulhern has forwarded to us the following interesting letter, dated November 26, 1949, which he received from Dr. Leonard Jan Bruce-Chwatt of the Malaria Service in Nigeria:

"Thank you very much for the two copies of Mosquito News received today and for your kind note.

"You will be interested to hear, I am sure, some recent news from 'darkest Africa' not quite as dark as often imagined.

"The Malaria Service had a long gestation period but was happily delivered into this world in March 1949 and I was requested to take care of the new-born baby and to nurse it and to bring it up 'for better for worse' as it were.

"We have moved the office and the laboratory from the Medical Headquarters in Lagos to the Yellow Fever Research Institute at Yaba, this being a sort of Bethesda of the capital of Nigeria. We are building another screened wooden hut with concrete floor to serve as a larger laboratory and in the meantime some work has already been done and more of it is planned. We are working on the bionomics of *A. gambiae* group, collecting data with reference to malaria in hyperimmune populations, carrying out a long term survey of a town called Ilaro where a large scale residual spraying program with benzene hexachloride will be put into operation early next year.

"Apart from this we started field chemotherapeutic trials of quinacrine, paludrine and chloroquine. We also run instructional courses for African Sanitary Inspectors.

"As you see our hands are full and we are hoping to have our staff increased from the present two (R. A. Fitzjohn and myself) to four.

"All being well and D. V. I hope to go to the States some time next summer for a few months and shall be delighted to see you again."

William B. Owen, Professor of Zoology, University of Wyoming, reviewed a paper for this month's *News,* and wrote the following to us in an interesting letter.

"I hope that my remarks on *A. punctulatus* reach you in time for the March issue of 'Mosquito News.' Writing an abstract of this report was like renewing contacts with an old friend of former years. Each reading of the paper recalled memories of Guadalcanal and our experience with this species. John. Belkin was perhaps the first person to start a colony of *punctulatus.* This was in Guadalcanal during 1944. He used an outdoor screened insectary and the colony was maintained for several months until a pilot missed his course and sprayed the area with DDT. Another colony was started at Malaria H.D.Q. on Guadalcanal early in 1945. I had supervision of this project for a while until we moved to the Philippines. As I remember, some of Schlosser's observations on the development of *W. bancrofti* in the mosquito host were based on our material. Belkin recorded information on his colony, but I have no record of it having been published. Unfortunately, very little of the work we did in the Solomons will ever appear in print.

"I will not be able to attend the meetings this month. Among the reasons for not attending is that I am still recovering from an automobile accident of last December. Perhaps Louis Olivier has told you that I was hit by a truck. The result was a broken clavicle, injured leg and other bruises. I have been on duty since early in January, but going at reduced speed."

EDITORIAL SECTION

It is customary for the orators, essayists and economists of a country to go back to the sayings and writings of the founding fathers for support of policies or theories that they are currently advocating. In these United States it might be to Washington or Franklin if they are speaking in general terms; or to Jefferson if they are Democrats and to Lincoln if they are Republicans.

With such a precedent the Editor may be pardoned if he refers to some writings of the founding fathers of the American Mosquito Control Association as the basis for certain editorial policies which have been followed.

From time to time the question has been voiced by sincerely interested persons as to whether *Mosquito News* should confine itself to the publication of papers on mosquitoes only, or even to papers on mosquito control only. Although it will be apparent to readers, if only from a perusal of the current issue, that the present editor believes in a more liberal interpretation of the function of *Mosquito News,* before referring specifically to certain articles it may be interesting to recall some previous discussions of the matter.

In a letter written in 1940 to Mr. Mulhern, Dr. Glasgow outlined some of his ideas for the new publication, which eventually became *Mosquito News* in its present form, and said, in part, that it should mean a "publication the quality of which would command a wide circulation to paid subscribers *in our own field and in related fields that are likely to be of interest to our particular group.*"

Later, but as early as 1942, in a report of the Publications Committee signed by several members, attention was called to the fact that mosquito control workers were being compelled to interest themselves in and inform themselves on "the whole field of community control of pests other than mosquitoes," and "many other special fields."

It was pointed out still later, in another report, that the membership of the Association comprises personnel from many related fields of public health service, including tropical medicine, medical and veterinary entomology, public health administration, public health engineering, and sanitary engineering in addition to malaria control as such and to pest mosquito control.

In the light of these early statements it is interesting to examine the appropriateness of the inclusion of some of the papers in the present issue.

There is a paper on the analysis of fat and excreta from persons exposed to DDT and handling DDT. This is, of course, of interest to public health workers; it is also especially interesting to mosquito control workers because so many of them not only handle DDT rather constantly themselves, but also because they are constantly having to defend their use of DDT in large scale control projects affecting entire regional populations. Surely, even if mosquitoes are not mentioned in the paper, mosquito control workers will be glad of its availability, and the availability of other toxicological papers, as well as papers on relative toxicities such as the one on benzene hexachloride and other compounds, in their publication.

Then, there are two papers on gnats—one gnat which is taxonomically close to the biting mosquitoes, and a biting species which is taxonomically more remote. Both of these papers describe unusually interesting control procedures and results, and both deal with problems where mosquito control agencies would logically be called in for action. The same is true for the papers on blackflies (Simuliidae) which *Mosquito News* has published.

This issue also contains a paper on malaria control in Venezuela. This is of interest not only to our many South American members and members in other Spanish speaking countries, but from the

now well nigh universal acceptance and application of many of the principles involved, to mosquito control workers everywhere.

Lastly, the issue is rounded out by some shorter papers dealing with taxonomy, morphology and distribution. Such papers may often seem of little interest in themselves to many of those who consider themselves only "practical" men—workers on the engineering or broader public health aspects of mosquito control—but it must be admitted by all that it is only through such studies, eventually applied, perhaps, by someone else to the local problems, that the necessary discrimination between species and habitats has been obtained to permit intelligent development, application, and appraisal of control measures.

It is firmly believed by the editor that only by this catholicity of content can *Mosquito News* continue to interest a sufficiently large circle of readers and subscribers, and continue to be a force in attracting and maintaining a sufficiently large membership in the American Mosquito Control Association, to widen its influence and to encourage continued progress.—D. L. C.

FUTURE EVENTS OF INTEREST TO MOSQUITO WORKERS

The *1950* Annual Meeting of the Florida Mosquito Control Association will be held April 16–19, at the Royal Palm Hotel, Ft. Myers, Florida.

The *1951* Annual Meeting of the New Jersey Mosquito Extermination Association will be held at Atlantic City, N. J., February 28, March 1 and 2.

The *1951* Annual Meeting of the American Mosquito Control Association will be held at Chicago, Ill., March 6, 7 and 8, with Otto McFeeley, of the Desplaines Valley Mosquito Abatement District, as chairman of arrangements.

MOSQUITO CONTROL INSPECTION TOUR IN NEW ENGLAND

Mr. R. L. Armstrong of the East Middlesex Mosquito Control Project of Cambridge, Mass., has announced a Mosquito Control Inspection Field Trip for July 11, 12, 13 and 14, 1950. Although the detailed program cannot be presented at this early date, following are some of the features that will probably be included:

1. Spraying for control of Tabanids ("greenhead flies"), and methods of making population counts of Tabanid larvae.
2. Spraying and fogging to protect a town located in a bad *Mansonia* area.
3. Demonstration of inspection for *Mansonia* larvae and use of emergence traps.
4. Pond cleaning for mosquito control work including the operation of a "Farm Pond" as advocated by U. S. Department of Conservation.
5. Automatic electric pumping station for drainage of a mosquito area.
6. Operation of scavel plow on tidal marsh.
7. Demonstration of Helioplane and Kaman helicopter.
8. Demonstration of aids to upland ditching.
9. Demonstration by shallow water boat spray equipment.
10. Study of places where weed killers have been used.
11. Visits to typical breeding areas of some of the less common mosquito species such as *Aedes aurifer, Theobaldia (Culesita) morsitans, Aedes atropalpus,* etc.

Persons who plan to make this tour should communicate (1) with Dr. D. M. Jobbins, New Jersey State Agricultural Experiment Station, New Brunswick, N. J., if living in the East, or (2) with Mr. Thomas D. Mulhern, 334 Rowell Bldg., Fresno, Calif., if living on the west coast.

ASSOCIATION NEWS

NEW OFFICERS AND COMMITTEES

As announced in the December number of Mosquito News the annual meeting of the American Mosquito Control Association for 1950 was held jointly with that of the Virginia Mosquito Control Association at the Cavalier Hotel, Virginia Beach, Virginia, on February 22, 23, and 24. Since the present number of Mosquito News was in press at the time, news of the meetings, including notes on business transacted and papers presented cannot appear until the June number. However, the Secretary was able to prepare immediately the official list of officers elected by the Interim National Board, and of committees appointed by the new Chairman of the Board, Mr. Lester Smith.

The other members of the Interim National Board are listed on the back cover of the *News*.

Publications Committee: Listed on inside front cover together with names of the editorial and business staffs of *Mosquito News*.

Membership and Subscriptions Committee: Chairman, E. Chester Robinson, East Side Mosquito Abatement Dist., P. O. Box 1023, Modesto, Cal.; Helen Louise Trembley, National Institutes of Health, Bethesda 14, Md.; Dr. Arnoldo Gabaldon, Jefe, Div. de Malariologia, Maracay, Venezuela; Dr. Luis Vargas, Apartado Postal 19206, Mexico, D. F.; R. J. VanDerwerker, Pan American Sanitary Bureau, 2001 Connecticut Ave., NW, Washington 8, D. C.; J. Lyell Clarke, 8130 Ogden Ave., Lyons, Ill.; A. W. Lindquist, BEPQ, USDA, Box 332, Corvallis, Oregon; Dr. Stephen M. K. Hu, Bur. Mosquito Control, Dept. of Health, Honolulu 1, T. H.; Edgar A. Smith, Merced Mosquito Abatement Dist., P. O. Box 1269, Merced, Cal.; Dr. C. R. Twinn, Dept. of Agriculture, Ottawa, Ontario, Canada; Dr. H. P. S. Gillette, P. O. Box 556, Port of Spain, Trinidad, BWI; Dr. A. D. Hess, USPHS, P. O. Box 769, Savannah, Ga.; J. A. Mulrennan, Florida State Board of Health, P. O. Box 210, Jacksonville, Fla.; Herbert A. Crandell, Toledo Area San. Dist., 225 Michigan Ave., Toledo, Ohio; Lt. Col. S. J. Carpenter, 041712, Army Surg. Office, Quarry Heights, Canal Zone; Helen Sollers, BEPQ, USDA, Washington 25, D. C.; Vernon Conant, Bergen Co. Mosquito Extermination Comm., Administration Bldg., Hackensack, N. J.; Dr. Alberto Missiroli, Instituto Superiore de Sanita, Rome, Italy; A. F. Cummings, Sr., Court House, Pittsfield, Mass.; John W. Scott, Vt. State Dept. of Agriculture, Montpelier, Vt.

Legislative Committee: Chairman, Robert L. Vannote, 3 Franklin Place, Morris Plains, N. J.; Harold F. Gray, 1 A Court House, Oakland, Cal.; Dr. Orson Whitney Young, Weber College, Ogden, Utah; H. W. Van Hovenberg, Mt. Pleasant, Texas; Rowland E. Dorer, 300 Essex Bldg., Norfolk, Va.

Audit & Budget Committee: Chairman, H. Duke Peters, 940 Main St., Jacksonville, Fla.; Perry W. Ruth, Mosquito Control Div., Dept. of Public Health, Norfolk 10, Va.; Herbert A. Crandell, 225 Michigan Ave., Toledo, Ohio; Arve H. Dahl, Chief, California Bur. of Vector Control, 2180 Milvia St., Berkeley 4, Cal.

Finance Committee: Chairman, M. M. Stallman, 15 Summitt St., E. Orange, N. J.; Dr. Paul F. Russell, The Rockefeller Foundation, 49 W. 49 St., New York 20, N. Y.; Arthur F. Geib, Kern Mosquito Abatement Dist., Box 907, Bakersfield, Cal.; H. H. Stage, BEPQ, USDA, Washington 25, D. C.; Harold F. Gray, 1 A Court House, Oakland, Cal.; Perry W. Ruth, Dept. Public Health, Norfolk 10, Va.; Marcus A. Donnelly, Room 1010, 921 Bergen Ave., Jersey City, N. J.; Dr. F. C. Bishopp, BEPQ, USDA, Washington 25, D. C.; Frank A. Steinrock, Todd Shipyards Corp., 81-16 45th Ave., Elmhurst, Queens, N. Y.

Advertising Committee: Chairman, Robert L. Vannote, 3 Franklin Place, Morris Plains, N. J.; Arthur F. Geib, Kern Mosquito Abatement Dist., PO Box 907, Bakersfield, Cal.; Richard F. Peters, California State Dept. Public Health, 2180 Milvia St., Berkeley 4, Cal.; Herbert A. Crandell, 225 Michigan Ave., Toledo, Ohio; Ralph C. Barnes, USPHS, 605 Volunteer Bldg., Atlanta 3, Ga.; Dr. F. C. Bishopp, BEPQ, USDA, Washington 25, D. C.; Robert L. Armstrong, E. Middlesex Mosquito Control Project, Court House, Cambridge, Mass.

Committee on Arrangements for 1951 Annual Meeting. Chairman, Otto McFeeley, Desplaines Valley Mosquito Abatement Dist., 8130 Ogden Ave., Lyons, Ill.; Dr. Spencer S. Fuller, 8130 Ogden Ave., Lyons, Ill.; J. Lyell Clarke, 8130 Ogden Ave., Lyons, Ill.; Herbert Crandell, 225 Michigan Ave., Toledo, Ohio.

Committee on Program for 1951 Annual Meeting. Chairman, Dr. Don M. Rees, University of Utah, Salt Lake City, Utah; Edwin Washburn, Turlock Mosquito Abatement Dist., PO Box 629, Turlock, Cal.; Dr. F. C. Bishopp, BEPQ, USDA, Washington 25, D. C.; Dr. B. B. Pepper, N. J. Agricultural Experiment Sta., New Brunswick, N. J.; Edwin L. Seabrook, Palm Beach Co. Anti-Mosquito Dist., Court House Annex, West Palm Beach, Fla., Wm. A. Legwen, USPHS, P.O. Box 1095, Macon, Ga.

REVIEWS AND ABSTRACTS

Malariology: A comprehensive survey of all aspects of this group of diseases from a global standpoint. By 65 contributors and edited by Mark F. Boyd. Two volumes, 1643 pages, published by the W. B. Saunders Company of Philadelphia, Pa. 1949. Price $35.00. Indeed it is a comprehensive survey of all aspects concerning the several malarias from a global standpoint! There are 70 chapters which are discussed under 5 sections: I, Introduction, a historical review by Dr. Boyd closing with this pertinent observation, "Although military exigencies of the last five years stimulated a great intensification of malaria research which has been highly productive, there still remain many opportunities for investigation which may yield significant contributions to the solution of the global problem;" II, Parasitology, 8 chapters on the species of the genus *Plasmodium,* an index of their hosts, life cycles of the malaria parasites, a photographic atlas of human plasmodia, a laboratory diagnosis of malaria infections, *in vitro* methods for study and the cultivation of plasmodia; III, Definitive hosts, 15 chapters in which insect vectors, the morphology, life history, physiology, and ecology of anophelines are discussed by prominent entomologists: IV, Intermediate host, 25 chapters on the epidemiology of malaria, distribution of malaria, malaria incidence, immunity to the malaria infections, symptomatology, chapters on *falciparum, quartan, vivax,* and *ovale* malaria, and others; V. Control and eradication, 21 chapters dealing with the several phases of controlling the disease by established practices in several regions of the globe.

Section III and V will be of greatest interest to the readers of "Mosquito News" for it is in these sections that the mosquito abatement officials will obtain the information so frequently sought on the species of anophelines of the nearctic, the neotropical, the palearctic, the Ethiopian, the Oriental and the Australasian regions, and their control. Some of these chapters are written by authorities whose names frequently appear in "Mosquito News" and most of them are members of our Association. F. C. Bishopp, E. F. Knipling, G. H. Bradley, W. V. King, Marston Bates, Luis Vargas, Arnoldo Gabaldon, Fred L. Soper, Justin M. Andrews and Alan Stone are included.

Such well known experts from over the world as P. A. Buxton, V. B. Wigglesworth, Botha de Meillon, I. M. Puri, Wilbur G. Downs, Colin S. Pittendrigh, Ernest C. Faust, L. W. Hackett, D. Bagster Wilson, Sir Gordon Covell, Herbert C. Clark, James J. Sapero, Sir Malcom Watson, Fred W. Knipe, and General James Stevens Simmons also have contributed additional chapters.

It is difficult to express any opinion other than one of profound admiration for a treatise so all-inclusive and exhaustive as Boyd's Malariology. It is well illustrated and is abundantly supplied with references. I feel that we must consider it unique in its field for, in its publication, Mark F. Boyd has initiated a monumental climax to his years of study on malaria and means for controlling the disease.

The work of preparing the outline, of organizing the chapters, and of obtaining the subject matter from a large group of scientists to meet deadlines must in itself have been an arduous task but in so doing the editor has accumulated authentic information from all over the world. Boyd maintains that it is his intention to make this publication, "A working manual of malariology, a comprehensive and adequate review or factual survey of all available knowledge relating to malaria objectively presented and brought down to date." Again, he has succeeded admirably.

In a compendium such as Boyd's "Malariology," there is one section that this reviewer would like to have seen included. It is intriguing to imagine a section on "Opportunities for investigation toward a solution of the global problem." Chapters might have been authored by a dozen contributors and the whole leavened by Boyd in the same able manner he fitted the existing 70 chapters into a masterpiece.—H. H. Stage.

Medical Entomology. By Robert Matheson. 2nd Edition. 612 pp. 4 plates, 242 figs. Publication date January 16, 1950. Comstock Publishing Company, Ithaca, N. Y. Price, $7.50. Since its publication 18 years ago, Professor Matheson's first edition of Medical Entomology has been a popular standard text and a valuable source of reference to all interested in insects and other arthropods that affect the health and comfort of man.

During the years that have elapsed since the printing of the first edition, great advances have been made in the knowledge of insect- and arthropod-borne diseases and of the vectors and pest species and methods of controlling them. This extension of knowledge was greatly accelerated during World War II when the need of protecting the armed forces and civilian populations from insect-borne diseases became paramount, and unprecedented opportunities for research and development in this field were provided.

The publication of a revised edition of Professor Matheson's book that includes this new knowledge is an event of great importance and one that has been eagerly awaited by workers in the field. His task in reviewing the voluminous literature that has been published on this subject since his first edition appeared must have been an extremely arduous and difficult one. His objective was to present an authoritative survey of present knowledge of value as a source of instruction and reference "to the physician, the entomologist, the public health worker, the student, and the layman." This was a truly formidable task, but one that Professor Matheson is exceptionally well equipped to carry out.

The book is well written, well organized, and contains a vast amount of information in readily accessible form. It presents details of the classification, morphology, life-histories and bionomics of the various insects and other arthropods, and the role they play in the dissemination of human diseases or as pests of man, and the materials and methods used in combating them. Keys are given to the various systematic groupings including keys to genera or species for the medically important forms.

The first chapter contains a brief historical survey of arthropods and human disease and the last (Chapter 20) deals with methods of collecting, preserving and mounting insects. The chapters in between discuss in detail the pests that affect human health and happiness; namely, the mites, ticks, lice, true bugs, psychodid flies, mosquitoes, black flies, punkies, tabanids, snipe flies, tsetse flies, the house fly and its allies, myiasis-producing flies, fleas, and poisonous and urticating arthropods. One-quarter of the book is devoted to mosquitoes: a reflection of their enormous importance to human health and welfare.

The book is profusely illustrated with excellent drawings and photographs. At the end of each chapter a selected bibliography is provided. The references in these lists which themselves provide long bibliographies are marked with asterisks for the information of the reader. In addition, an extremely useful feature, at the end of Chapter 1, is a list of journals, textbooks, and other publications that students and investigators should consult if they wish to obtain the latest information and keep abreast of advancing knowledge.

In preparing and publishing this revision of his book on Medical Entomology, Professor Matheson has performed an outstanding public service and has earned the gratitude of all whose activities or interests are connected with this field of endeavour.—C. R. Twinn.

EFFECTS OF DDT MOSQUITO LARVICIDING ON WILDLIFE.. IV. THE EFFECTS ON TERRESTRIAL INSECT POPULATIONS OF ROUTINE LARVICIDING BY AIRPLANE. By Scudder, H. I., and Tarzwell, C. M. Pub. Hlth. Repts. 65(3):71–87. 1950. Mosquitoes, deer flies, and sand flies were reduced in numbers by the routine larvicidal treatments; however, for other than these forms, no over-all effect of the treatments was observed. Observations in check and treated areas showed only those differences in general insect numbers and activity which could be considered to be due to differences in the respective ecological situations. Grasshoppers, ants, dragon-flies, wasps, bees, and other common forms appeared in usual abundance during the first season of treatment.

Examination of water areas shortly after treatment disclosed considerable numbers of dead insects, especially may flies, damsel flies, certain beetles *(Donacia)*, and dolichopodid and acalyptrate flies; however, during the first season there was no evidence of any general diminution of damsel flies and dragonflies on the wing or of aquatic insects in general. Aphid colonies in treated and check areas showed no significant differences in vigor or in the occurrence and number of parasites and predators.

Experimental beehives kept under observation during the first season of treatment showed no over-all adverse effects and produced a crop of honey normal for the year. During the two succeeding years of treatment, beekeepers kept many colonies in treated areas with no reported adverse effect, indicating that routine DDT mosquito larviciding is not detrimental to honey production.

Light-trap catches in treated and check areas during two seasons' treatment showed no significant over-all reduction in the insect population of areas adjoining those routinely larvicided with DDT at 0.1 pound per acre with the possible exception of the Trichoptera.—Authors' Conclusions. (Editor's note: The above studies were made in 1946 and 1947 in Jasper County, Ga., at the Savannah Migratory Waterfowl Refuge, which lies "within the lower Savannah River tidal bottoms, which are generally brackish." According to the authors, "the areas studied were protected from tidal fluctuation and brackish water by a system of dikes.")

THE MOSQUITOES OF BWAMBA COUNTY, UGANDA. VII.—INTENSIVE CATCHING ON TREE-PLATFORMS, WITH FURTHER OBSERVATIONS ON AEDES (STEGOMYIA) AFRICANUS, THEOBALD. By A. J. Haddow, and A. F. Mahaffy. Bull. Ent. Res. 40(2):169–178. 1949. In an attempt to isolate yellow fever virus from *Aedes (Stegomyia) africanus*, Theo., an intensive series of catches was carried out during 11 weeks of 1945 in 2 forest areas in Bwamba County, Uganda. Most of the work was carried out on platforms in trees during the sunset period, since the main biting activity of *A. africanus* occurs in the forest canopy just after sunset. Virus was not obtained during the course of this work.

The results confirmed that *A. africanus* is the dominant arboreal Culicine of the sunset period. In catches carried out actually in the canopy it formed 69 per cent of the total Culicines taken. Other species particularly common in the canopy in the sunset period were *Taeniorhynchus (Mansonioides) africanus*, Theo., *Anopheles (Myzomyia) gambiae*, Giles, and the Tabanid, *Chrysops centurionis*, Aust.

A result of particular interest was the capture of 2 *Aedes (Stegomyia) aegypti*, L. in the trees of one study area, and of 13 actually in the forest canopy of the other. Both areas are primary rainforest, and native huts are very scarce in the vicinity. It is pointed out that *A. africanus* is peculiarly susceptible to the influence of weather conditions, and that low temperatures may partly or even completely inhibit its biting activity in the sunset period. The methods of feeding *A. africanus* on rhesus monkeys in captivity are described. The remarkable speed with which this species engorges is discussed.

The close relationship between *A. africanus* and

A. (*S.*) *luteocephalus* is discussed. The writers believe that the differences between these mosquitoes do not warrant full specific rank for *A. luteocephalus,* more particularly as intermediate forms have been found.

The methods of inoculating triturated mosquitoes into laboratory animals in the field are described.—Authors' Summary.

Studies on West African Forest Mosquitos. Part I.—The Seasonal Distribution, Biting Cycle and Vertical Distribution of Four of the Principal Species. By P. F. Mattingly. Bull. Ent. Research 40(1):149–168. 1949. The present paper is the first of two dealing with the seasonal distribution, hourly variation in biting activity, and vertical distribution of certain Southern Nigerian mosquitos. The technique employed in the studies under discussion resembled that used by Haddow (1947) in Uganda. Human bait was used in both cases and the agreement between the results obtained in the two localities is felt to be such as fully to justify the employment of such methods. Over 50 species of mosquitos were taken in all and 14 of these proved to be sufficiently abundant to yield significant figures. Four of these are discussed and the remainder will be dealt with in the second paper.

The most remarkable feature of the seasonal distribution was the very restricted period during which *Anopheles gambiae* was present in any abundance. This species occurred in large numbers only during the heavy rains of June and July and, to a less extent, in association with the small rains of September–October. During the dry season it almost disappeared. *Aedes africanus* showed a similar distribution to that of *gambiae* but *Taeniorhynchus africanus* and *Anopheles hargreavesi* were most numerous during the dry season. It is suggested that in the area under consideration the latter species may well be a more important malaria vector than *gambiae* owing to its greater abundance and more uniform seasonal distribution.

As in Uganda *Aedes africanus* proved to be mainly a tree-top biter with a well-marked peak period of biting activity associated with evening twilight while *A. gambiae* and *A. hargreavesi* bit mainly on the ground and had their peak period in the morning. The biting cycle (hourly variation in biting activity) of *hargreavesi* showed considerable differences from that of *gambiae* but on analysis these proved to be superficial and to be due mainly to a difference of about one hour in the times of occurrences of their peak biting periods and a corresponding change in the vertical distributions with which these were associated. The occurrence of peak activity in the early morning in *A. gambiae* is considered to have an important bearing on the question of personal precautions against malaria.

The biting cycle of *T. africanus* differed from that of any other species studied in that the period of peak activity occurred during the middle part of the night, the exact time varying quite widely on the various occasions on which observations were made. It is suggested that this may have been due to the occurrence of both morning and evening peak periods within the same species.

Details are given of the variations in temperature and humidity encountered during the experiments together with meteorological observations made at a neighboring airfield but a full discussion of the relation of these factors to the activity of the mosquitos is reserved for the second paper when all the data will have been presented. —Author's Summary.

Diurnal Mosquitoes in an Area of Small Residual Forests in Brazil. By Causey, O. R., and Dos Santos, G. V. Ann. Ent. Soc. Amer. 42(4):471–482. Observations on diurnal mosquitoes in residual forests in the region of Passos, Minas Gerais, were undertaken as a part of a study of a region that had been invaded by jungle yellow fever 10 years previously. Specimens were collected on human bait at ground and tree-platform levels at 4 stations in 4 different forests, during 4 days a week over a continuous period of 120 weeks. Hourly, weekly, monthly, and seasonal records were made. Parallel meteorological data was assembled. A total of 73,321 mosquitoes, including 9,788 *Haemagogus spegazzinii,* were taken. The highest monthly rate per man hour was 17.1 for all mosquitoes, and 5.0 for *H. spegazzinii* in January, 1946. *H. spegazzinii* and other tree-hole breeders were fewer in number during the second rainy season, and showed evidence of being still further reduced during the first half of the third wet season, when this study was terminated. This may indicate that there exists a cycle of several years' duration in the Haemagogus population in addition to the usual seasonal cycle, and that these studies were undertaken on the low side of this large cycle. —Authors' Summary.

Método de Lucha Anti-*Aedes* Aplicado en Iquique (Chile). Drs. A. Neghme, R. Montero, J. Villalón and J. Gutiérrez, and H. Albi and A. Reyes. Bol. Inform. Parasitarias Chilenas. Vol. IV, No. 2, pp. 4–6. Apr.–June 1949.

This paper reports an unusual and apparently very successful method of controlling *Aedes aegypti,* by treating the public water supply with DDT before it is used by the people.

Iquique (which is about 75 miles south of the Peru-Chile border, on the Pacific) is a port town of about 48,000 people and 9,000 houses. It is in desert country, and rain is almost unknown. The water-supply is brought from an oasis upcountry to several large tanks, and from these is distributed in pipes to the houses. This water stands in the tanks for about 24 hours before being distributed. The only breeding-places of *aegypti* were household water-containers of various sorts.

The water in the tanks was treated with a suspension of DDT, to a final dilution of 1 part in one million. This dose is lethal to the larvae of *aegypti,* but innocuous to humans. "The

results were spectacular." Larvae of *Aedes aegypti* and of *Culex* practically disappeared in less than 24 hours. Dead larvae were found in the bottom of containers of treated water. The *aegypti* house index of adults, which was initially 10.7 percent, dropped to zero in a few weeks.

The authors hope that a second application of DDT four or five months after the first will completely eradicate *Aedes aegypti* from Iquique. They plan to use this ingenious method of mass treatment of the water-supply in other places where conditions are favorable. W. H. W. Komp, National Institutes of Health, Bethesda, Md.

1. *Aedes (Stegomyia) pseudoafricanus* SP. NOV.: A NEW SPECIES OF *Aedes* FROM THE COAST OF NIGERIA (BRITISH WEST AFRICA). Chwatt, L. J. Nature 167:808. May 1949. This mosquito is closely related to *Aedes (S.) africanus* Theo., and the main difference between the two "lies in the structure of the male terminalia." Both are tree-hole breeders.

2. A NEW VARIETY OF *Anopheles aitkeni* FROM BORNEO. McArthur, J. Bull. Ent. Res. 40(1): 49–52, 2 figs. May 1949. *Anopheles aitkeni* var. *borneensis,* nov. differs principally from *A. aitkeni bengalensis* Puri in the structure of the male terminalia. The larvae of the known varieties of *A. aitkeni* can be separated on the basis of variations in the anterior clypeal hairs. A summary of these variations is given.

3. THE *Anopheles* OF TAMBUNAN, NORTH BORNEO. McArthur, J. Bull. Ent. Res. 40(1): 53–60. May 1949. Accounts are given of the habits and characteristics of twelve species or varieties of *Anopheles.* The data resulted from surveys conducted during 1939–42. *A. leucosphyrus* Dönitz, the most important malaria vector, breeds in small seepages in dense jungle, is widespread and abundant, but is difficult to collect. *A. maculatus* Theobald is widespread but is not a vector in Tambunan, although it is important elsewhere in Malaya. The most widely breeding species in Tambunan Plain was *A. barbirostris* Wulp., but the adults are rarely seen; it is of little importance as a malaria vector.

4. CULICINE MOSQUITOES COLLECTED IN WESTERN YUNNAN, CHINA DURING 1940–42. Chow, C. Y. Proc. Ent. Soc. Wash. 51:127–132. June 1949. Collections were made at Chefang and vicinity, a subtropical region near the Burma border. Among the forty-four species found, all but one are newly recorded for Yunnan province, and 19 species are new to China. Their breeding places and known geographical distribution in other provinces of China are given. Eleven genera are represented.

5. THE IDENTIFICATION AND DISTRIBUTION OF CHINESE ANOPHELINE MOSQUITOES. Chow, C. Y. Journ. Nat. Mal. Soc. 8:121–131. June 1949. A table shows the distribution of 38 species or varieties of anophelines by provinces. Twelve species have been added to the records since 1938. Keys to adult females and full grown larvae are given. There is an annotated list of species with emphasis on habits of larvae and relation to malaria.—Wm. E. Bickley, U. of Maryland, College Park, Md.

LABORATORY BREEDING OF *Anopheles punctulatus punctulatus* Dönitz. By M. J. Mackerras, and T. H. Lemerle. Bul. Ent. Res. 40(1):27–41. May 1949. This is the first complete report on the management of a laboratory colony of *Anopheles punctulatus punctulatus* Dönitz. The observations were made during the war at Cairns, North Queensland, Australia. The mosquitoes used in establishing the colony were obtained from New Guinea. The paper describes methods of rearing and records observations on the life cycle and behavior.

The adults of this species require a relatively high temperature, space for mating and oviposition, high humidity and a rhythm of light conditions corresponding to day and night. The insectary and cages were designed to meet these basic needs. The insectary was maintained at a temperature of approximately 27° C. and provided with a number of windows to furnish natural illumination. The cages were 3′ x 2′ x 2′ and constructed of compressed wood. Two sides of each cage were made of glass in order to admit light. A relative humidity of 90% was maintained in the cages.

The adults were fed on fresh slices of apple and offered a blood meal as necessary. The arm of a human volunteer was found more satisfactory as a source of blood than the use of an animal.

The larvae were reared in shallow enamel dishes and fed "Farex" a proprietary brand of baby food. A routine plan was followed in the feeding and care of larvae. Oviposition dishes containing soil and water were removed from the cages daily. The larvae were kept in these dishes until 3 days of age and then transferred to rearing dishes containing sand and water. These bowls were 7½″ in diameter and 1½″ deep and would accommodate 300 or more larvae. As the pupae appeared they were removed from the culture, washed thoroughly and transferred to clean water. The emergence rate of adults reared under this plan varied from 95 to 100%.

Duration of the various stages in the life cycle, under insectary conditions, was normally: egg, 42 hours; larval, 5–8 days; pupal, 30–40 hours; emergence to first blood-meal, 2 days; first blood meal to oviposition, 3 days; total from egg to adult, 13 days.

The breeding cycle and behavior of this species follows a definite rhythmic pattern. Adults begin to emerge in the late afternoon and continue throughout the night. Biting activity is usually restricted to the hours of darkness and mating occurs at twilight. Mating is accomplished while the two sexes are in flight. Oviposition occurs during a hovering dance over the water and takes place in the early evening. Hatching begins in

the afternoon and pupation is confined to a few hours during the afternoon.

This is a highly factual report and represents a significant contribution to our knowledge of one of the most important malaria vectors in the Australasion region.—William B. Owen, University of Wyoming, Laramie, Wyo.

Observations of Mosquitoes Breeding in Plant Containers in Yunnan. By Chow, C. Y. Ann. Ent. Soc. Amer. 42(4):465–470. 1949. The object of the paper is to summarize observations on mosquito species with specialized larval habitats in plant containers. These observations were made during the mosquito faunal survey of the Chefang region in western Yunnan, carried out during 1940 to 1942.

The author describes a survey of "water container" breeding sites in which 36 species were found. Tree holes produced 11 species, bamboo stumps 18, leaf bases of bananas one, pineapple plants one, an unidentified aroid 2, a native plant called "tun-tun" 2, and an Agave-like plant called "Mou-in-ka", one species. These mosquitoes belonged to the genera Megarhinus, Tripteroides, Topomyia, Harpagomyia, Uranotaenia, Orthopodomyia, Aedes (Stegomyia and Finlaya) Heizmannia, Armigeres and Culex (Neoculex, Lophoceratomyia and Culiciomyia).

Studies on hibernation in tree holes and bamboo stumps are also described. Bamboo stumps were collected and later filled with water. Material from tree holes was brought in and immersed. Hatching occurred and 7 species, all of the genus Aedes were identified.—William E. Beckel, Defense Research Northern Laboratories, Churchill, Canada.

"A MESSAGE TO ALL MEMBERS OF THE AMCA.

The American Mosquito Control Association has during the past few years made very fine progress in gaining new members and in improving the quality of its journal, 'Mosquito News'. It has begun truly to represent the interests of mosquito workers in the Americas and is also gradually coming to serve the needs of countries outside the western hemisphere.

President Lester W. Smith has appointed a new committee on membership, to take up the important task of acquainting non-member mosquito workers with the advantages of participation in the association, and this committee will do all it can to discharge its responsibilities, to bring in new members, and to increase the revenue of the association, which in turn may be expected to permit the publication of a still larger and better 'Mosquito News'. But the committee cannot possibly canvass all potential new members.

On behalf of the Association, every present member is urged to try to get at least one new member, before July 1. A blank is included in this number of Mosquito News. Will YOU use it to try to get a new member?

For the Membership Committee:
Chester T. Robinson, Chairman
(P.O. Box 1023 Modesto, Calif.)"

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